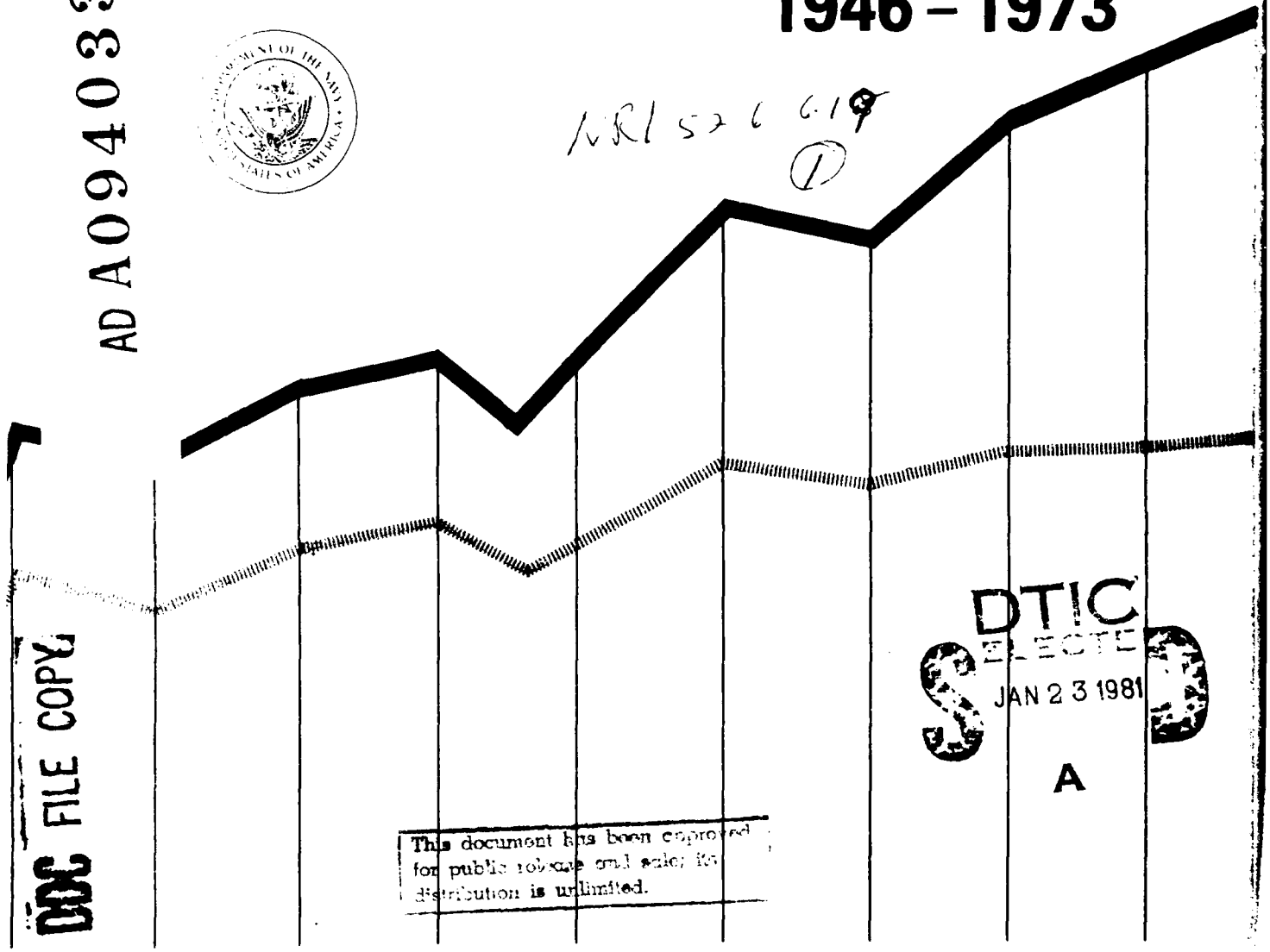
REVIEW OF NAVY R & D MANAGEMENT 1946 - 1973

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REVIEW OF NAVY R&D MANAGEMENT
1946-1973



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Prepared by

Booz, Allen & Hamilton Inc.

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PREFACE

This Review was initiated by senior Navy officials who realized that the corporate memory of significant events in the evolution of Navy R&D management since World War II was rapidly diminishing; many of the key members of the Navy R&D community in the postwar era had left the naval service and retirement of others was imminent. Management solutions, previously tried and found wanting, were beginning to reappear; the rationale behind others was blurred by the passage of time.

While numerous case studies had been prepared on various projects and historical information figured prominently in several Navy management studies, there had been no systematic attempt to review and document the circumstances surrounding significant developments: the issues, the alternatives, and the decisions from which many major changes derived. To fill this gap and to provide historical perspective for future decisions by senior Navy Department officials, the Navy contracted with Booz, Allen & Hamilton Inc. to undertake a comprehensive review of events between 1946 and 1973 that had a major impact on Navy R&D management.

Prior to initiating work, Booz, Allen and the Navy Department agreed that, to the extent that they contribute to the objective of the Review, the following subjects would be covered:

- Characteristics of each period within the era in terms of external and internal influences, issues, needs, key individuals, and management philosophy
- Organization and its evolution in terms of structure, relationships, responsibilities, and authority
- Principal policies and procedures and their influence on management efficacy
- Important projects; their urgency and significance
- Level of resources applied to R&D and trends therein
- Noteworthy results, achievements, and failures
- Impact of above factors on R&D field activities and industry.

In addition to the general scope of the Review, several guidelines for the conduct of the research were developed jointly by Booz, Allen and the Navy. First, the Review was

to be based not only on examination of available documents but also on personal interviews in order to record perceptions of persons directly involved in past events. Second, major emphasis would be on R&D management in the Navy Department, e.g., treatment of field activities would be limited to top-level policy issues in which headquarters agencies were directly involved rather than internal (laboratory) management. Third, the study would concentrate primarily on R&D management as applied to development programs; naval research would be addressed only to the extent necessary to provide a balanced perspective. Fourth, the study would not comprise a series of case studies of specific weapons systems development projects, although available case studies could be utilized to illustrate the relevance of issues and the application of actions or decisions. Finally, the Review would focus on the origins and effects of key Navy R&D management issues most likely to be relevant to problems that senior Navy Department officials might face in the future.

During the research phase of the project, five major subjects were identified as areas of primary interest: Headquarters R&D Roles and Relationships, Navy RDT&E Field Activities, R&D Program Planning, R&D Financial Budgeting and Appropriations, and Program Execution. The final document incorporates these five parts, for which changes from the 1946 baseline are described.

In conducting the research, Booz, Allen's project team examined hundreds of pertinent documents and interviewed over 75 individuals directly involved in past events. Naturally, the quantity, quality, and availability of historical records varied significantly from subject area to subject area. Some gaps in statistical data were notable. In other areas, such as program planning, procedures were well documented but administration of these procedures was highly sensitive to the styles of individual managers. It was, therefore, difficult to treat them uniformly or comprehensively over the entire time span. Program execution was also susceptible to widely varying approaches according to the type of effort, organizations, and individuals involved. Operating patterns were highlighted in these cases, therefore, rather than specific events.

Where necessary and appropriate, reliance was placed on memories and observations of former participants in the R&D process. Extensive interviews aided in filling data gaps and reconciling some discrepancies as well as enhancing perspectives on the origins and impacts of significant events. The interviews ranged from formal taped sessions to informal meetings and telephone conversations. To preserve the confidentiality of the interviewees, all references attributed to them in the final document are uniformly cited "Personal Interview." A complete list of persons contacted is included in Appendix F.

Although strenuous attempts were made to minimize overlapping and duplication of information, it was sometimes unavoidable. In addition, a large body of information was gathered which was pertinent to the subject, but either inappropriate or too lengthy to be included in the body of the text. For ready reference, some of this material has been placed in several appendices.

In keeping with the Navy's request, Booz, Allen refrained from drawing conclusions and making recommendations. Each Part of the Review, however, contains a summary of principal trends, commentary, and perspectives on the topic covered, derived mostly from interviews. The separately bound summary of the entire Review also contains such material.

Successful completion of this Review within available time and resources required the dedicated efforts of a number of people. Captain Robert L. Hansen, USN (Ret.), Mrs. Susan Frutkin, and Dr. Peter Bruton were the principal investigators and Mrs. Mary E. Ball was the chief editor on the Booz, Allen project team, which was ably assisted by various members of the professional and support staff. Dr. Sam Rothman, George Washington University, served as a contributing author and assisted greatly in reviewing and commenting on the manuscript. In addition, the Navy Department selected an Editorial Board of the following prominent members of the Navy R&D community:

Dr. R.O. Burns, Chairman
Rear Admiral B.H. Andrews, USN (Ret.)
Vice Admiral H.G. Bowen, USN (Ret.)
Rear Admiral L.D. Coates, USN (Ret.)
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Dr. Harvey Sapolsky
Mr. Bernard Smith
Dr. James H. Wakelin, Jr.

The Board provided policy guidance and advice as well as review and comment on draft material at successive stages. Their assistance and recommendations proved invaluable throughout the project in defining and shaping the Review. Finally, the assistance of the numerous persons interviewed, many of whom gave generously of their time, is gratefully acknowledged.

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PART I

HEADQUARTERS R&D ROLES AND RELATIONSHIPS

Part I traces the transformation in Navy headquarters organizations involved in the management of research and development that occurred in the years 1946-1973. When viewed from the perspective of today, it can be seen that this transformation was at once complex and dynamic.

R&D came of age as a major military responsibility with the advent of the Second World War. The outbreak of the war in Europe prompted the establishment of a national R&D organization, the Office of Scientific Research and Development (OSRD), and an unprecedented merger of civilian and military manpower. The war also produced a decisive acceleration in expenditures for military R&D. In the Navy, expenditures rose from the modest sum of $8.9 million in 1940 to $167.7 million 4 years later.

Navy Department organization for R&D during the war and immediately thereafter was relatively simple. The Chief of Naval Operations through the COMINCH organization determined fleet requirements, and the material bureaus translated those requirements into actual hardware developments. Organization for R&D varied from bureau to bureau, but essentially each bureau had a separate R&D unit. In addition, there was a separate research organization, the Office of Research and Inventions. Internal coordination was the responsibility of the bureau chiefs who were represented on a Research and Development Board chaired by a Coordinator of R&D. The OSRD and later the Joint Research and Development Board coordinated R&D matters between the Navy and War Departments.

During the next 27 years, headquarters R&D roles and relationships grew exceedingly complex. A principal catalyst in the transformation was the appearance of the Office of the Secretary of Defense (OSD). Created in 1947, OSD gradually assumed statutory responsibility and authority for direction and control of defense R&D. One result of the centralization of authority for defense policy was a growing demand for information and justification of Service programs. To meet the demand, R&D staffs emerged at virtually all levels of the Navy Department. This had the effect of raising the visibility and importance of R&D within the Navy but also contributed to the erosion of authority of the material bureaus. Another contributing factor in the bureaus' demise was the appearance of ad hoc offices for intensified management of specially designated programs and projects.

Part I is divided into six chapters. A baseline chapter depicts the Navy R&D organization of 1946. The remaining five chapters examine changes in headquarters R&D roles and relationships that occurred during the era. Because of the interrelationship between Navy and OSD R&D organizations, Part I presents background material on major changes at the OSD level followed by in-depth coverage of the evolution of R&D organization within the Navy.

CHAPTER 1

BASELINE 1946

At the outset of the era, the Navy Department organization for R&D presented a state of contrasts. On the one hand there was the stability provided by the material bureaus. Established initially in the mid-19th century, the bureaus had assumed principal responsibility for research and development activities. They reported directly to the Secretary of the Navy on material matters and enjoyed considerable prestige within the Department. On the other hand, the transition to a peacetime Navy prompted considerable change. For example, the Office of the Chief of Naval Operations underwent a major reorganization in late 1945. At the same time, the Navy established the Office of Research and Inventions as part of a concerted effort to retain some of the scientific expertise acquired during the war.

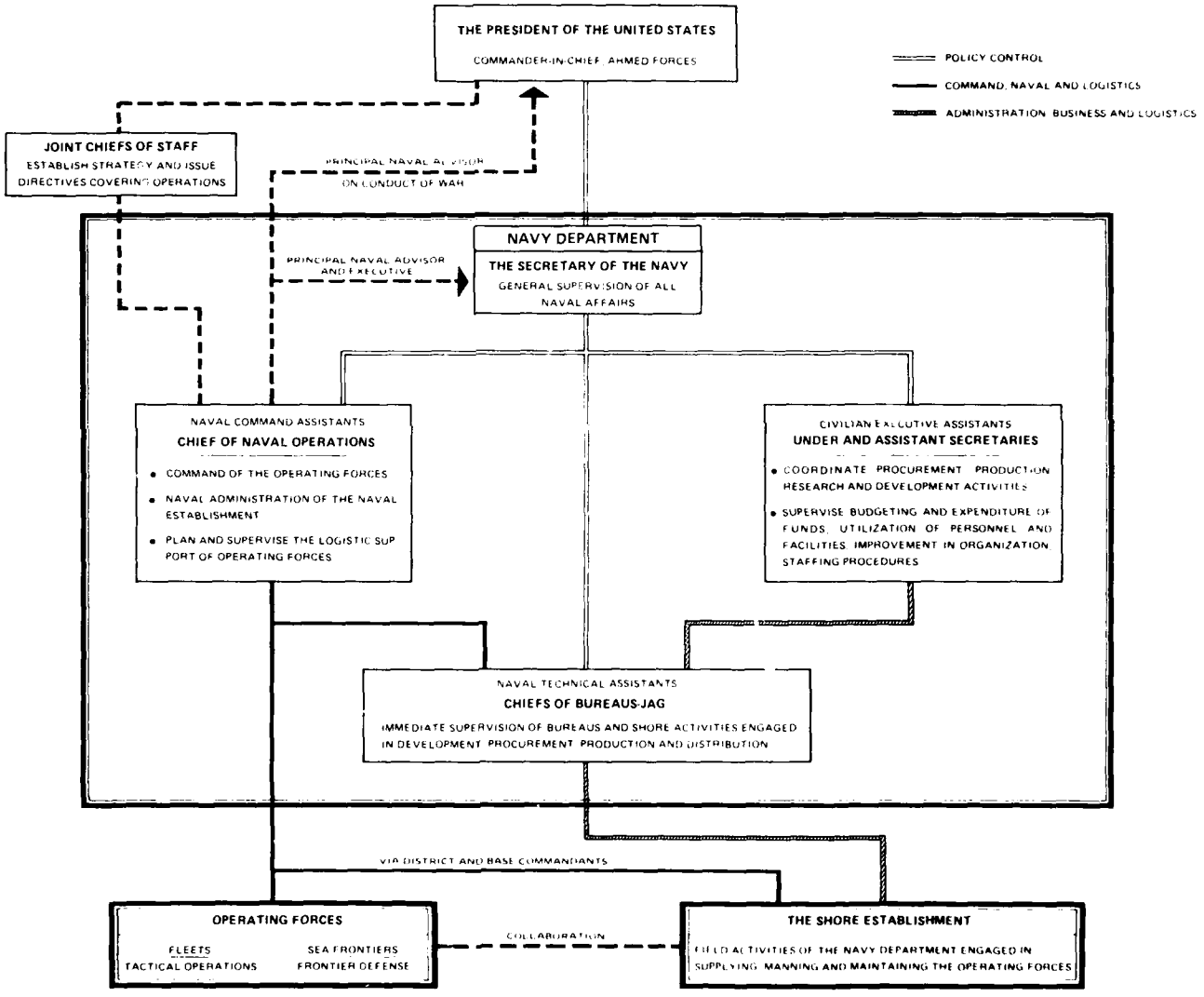
This chapter examines the roles and relationships of those responsible for managing the Navy R&D program during the first year of the postwar era. It provides a baseline from which subsequent change can be measured.

THE BILINEAR ORGANIZATION OF THE NAVY DEPARTMENT

As indicated in Exhibit I-1, the postwar Naval Establishment was divided into three principal elements: the Navy Department, the Operating Forces, and the Shore Establishment. At the beginning of 1946, the Navy Department comprised the bureaus, boards, and offices located at the seat of government, including the Offices of the Secretary of the Navy, his civilian executive assistants, and the Chief of Naval Operations, as well as the Headquarters of the Marine Corps. These bureaus and offices functioned within what was commonly referred to as the bilinear organization. The salient features of this concept were as follows:

- The Secretary of the Navy was responsible directly to the President for the supervision of all naval affairs. He maintained direct and complete "policy control" of the Naval Establishment, exercising it through his civilian executive assistants and his naval professional assistants—the Chief of Naval Operations, the Chiefs of the bureaus, the Judge Advocate General, and the Commandant, Marine Corps.

EXHIBIT I-1
Overall Operating Organization of the Naval Establishment



- The civilian executive assistants included the Under Secretary, Assistant Secretary, Assistant Secretary (Air), and an Administrative Assistant. They were responsible for "business administration" which entailed developing and maintaining efficiency and economy in the operations of the Naval Establishment with particular regard to matters of organization, staffing, administrative procedures, the utilization of personnel, materials and facilities, and the budgeting and expenditure of funds.

- The Chief of Naval Operations was responsible for naval command. He directed the Operating Forces, maintained them in a state of readiness to conduct war, and promulgated to the Naval Establishment directives embracing matters of operations, security, intelligence, discipline, naval communications, and similar matters of naval administration.

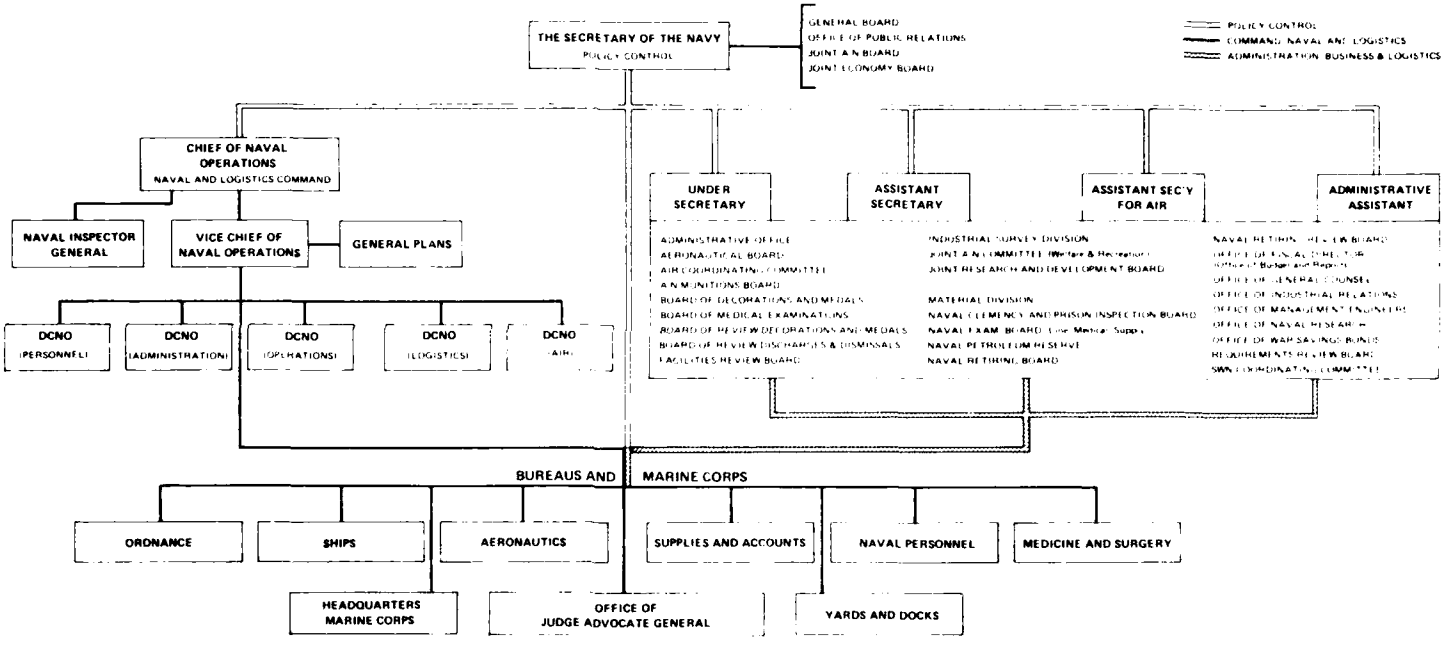
- Responsibility for "logistics administration and control" was split in a bilinear fashion that reflected the division of responsibilities for "naval command" on the one hand and "business administration" on the other. The Chief of Naval Operations had authority for "consumer logistics" which entailed planning and forecasting the needs of the fleet, issuing statements of operational requirements, reviewing and evaluating the progress of the bureaus and offices in fulfilling the requirements, and collaborating with the civilian executive assistants in matters of mutual interest. "Producer logistics" was under the purview of the bureau chiefs who were responsible to the Secretary for research, development, procurement, production, and distribution of materials and facilities.[1]

RESPONSIBILITY AND AUTHORITY FOR RESEARCH AND DEVELOPMENT

As noted above, the principal responsibility for developing and acquiring material for the fleet in response to the CNO resided in the bureaus. Established by an Act of Congress in 1842, the bureaus served as agents of the Secretary providing for the material needs of the Operating Forces. Over the course of the next century, the number of bureaus fluctuated, but their independence of action, in terms of each other and the Operating Forces, remained intact.

As indicated in Exhibit I-2, there were seven bureaus: Ordnance, Ships, Aeronautics, Supplies and Accounts, Personnel, Medicine and Surgery, and Yards and Docks. Each was under the administration of a flag officer with line authority over his organization. By virtue of the clear lines of authority and accountability, the bureau chiefs enjoyed virtual autonomy in technical and business management matters. In considering the breadth of authority held by the bureau chiefs, it is only necessary to recall that the bureaus

EXHIBIT I-2
The Navy Department 1946



represented the third organizational echelon of the executive branch, ranking just below the President and the cabinet-level departments. Their position in the governmental hierarchy ensured considerable latitude in their administration of bureau affairs.

While most of the bureaus participated in some form of research and development activities, most of the R&D budget was administered by the three material bureaus, the Bureau of Ordnance (BuOrd), the Bureau of Ships (BuShips), and the Bureau of Aeronautics (BuAer). As indicated in the paragraphs below, the organization for R&D varied to some extent among the three material bureaus.

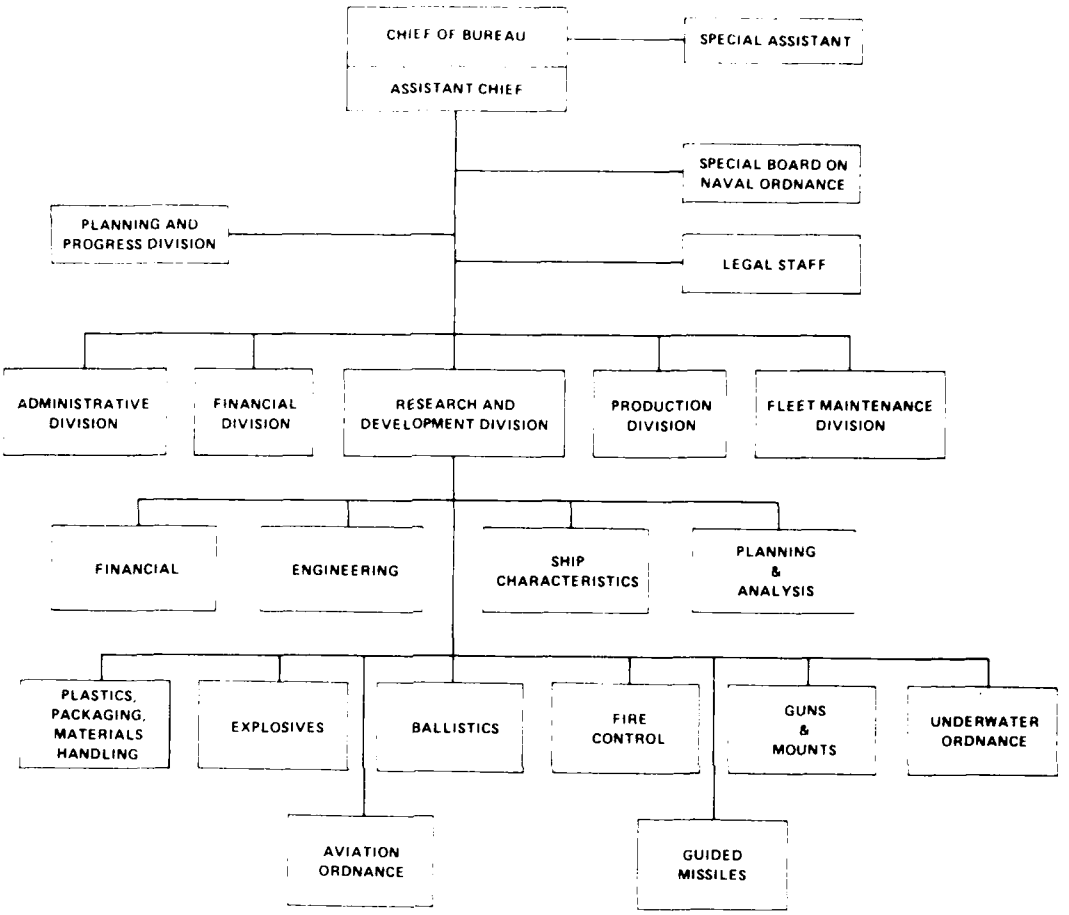
Bureau of Ordnance

BuOrd designed, procured, issued, and maintained all offensive and defensive arms and armament and other devices for the control of guns, bombs, torpedoes, and rockets. As illustrated in Exhibit I-3, BuOrd designated a separate division with sole responsibility for research and development. The division, administered by an Assistant Chief (Research), had responsibility for directing and implementing research, design development, and experimental projects including work assigned to the field activities, in-house laboratories, private contractors, and universities. Within the R&D division were eight product-oriented branches which were further divided according to specific technical/product areas. For example, the Guided Missile Branch had responsibility for initiating and directing all research, development, design, and experimental activities of guided missiles and was subdivided into separate sections for research, development, and coordination.[2]

Bureau of Ships

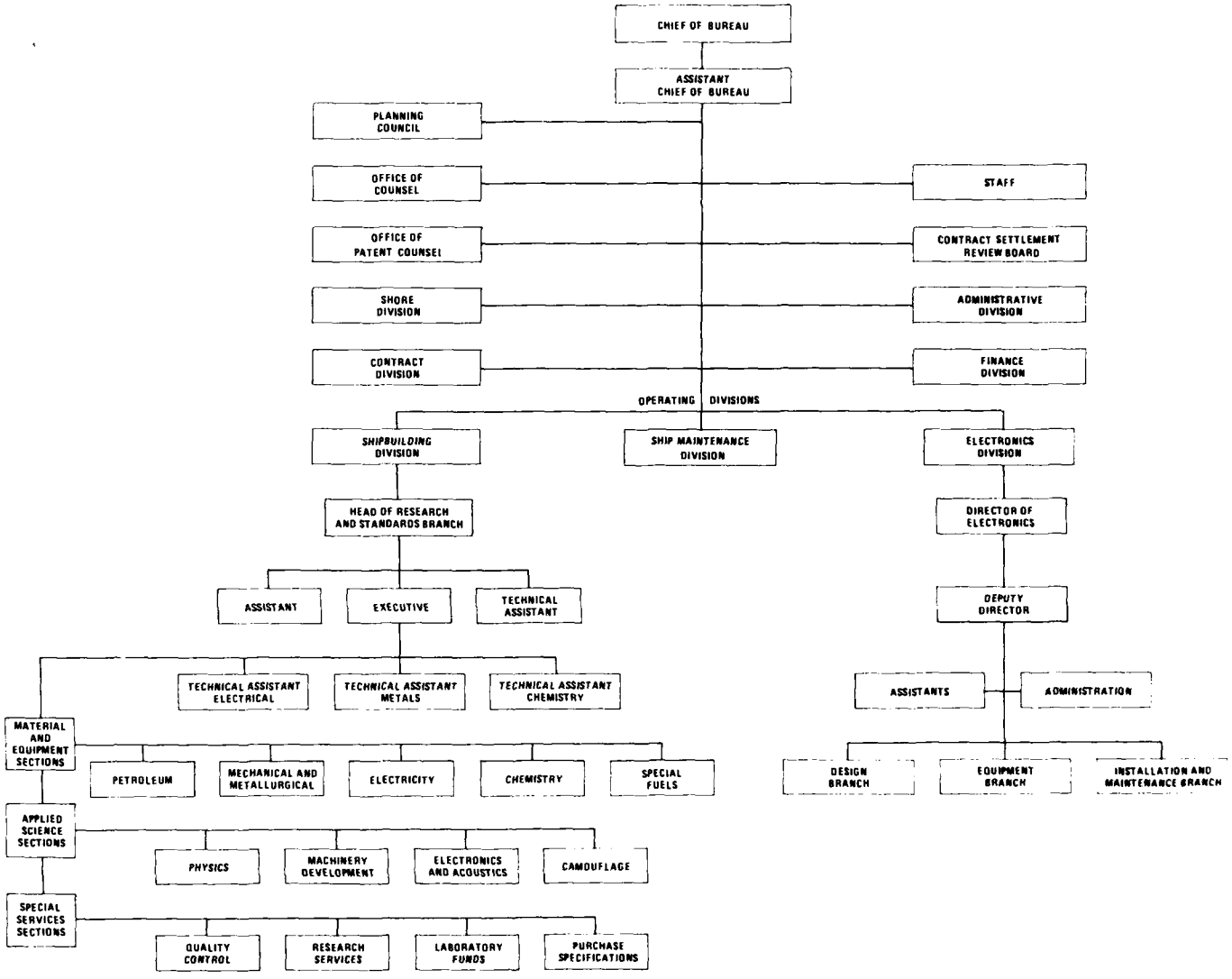
The Bureau of Ships had responsibility for the design, construction, procurement, and maintenance of ships, small craft, and radio, sound, and other equipment. As illustrated in Exhibit I-4, there were three principal operating divisions within BuShips: Shipbuilding, Ship Maintenance, and Electronics. The R&D function was split between the Shipbuilding and Electronics Divisions. Within the Shipbuilding Division, a Research and Standards Branch assumed control for research and development. The branch initiated, sponsored, and coordinated the research, development, and testing activities of the division and had cognizance over the bureau laboratories and field activities. Integral elements of the branch were the technical sections which assumed technical responsibility for specific types of equipment.

EXHIBIT I-3
Bureau of Ordnance 1946



In the Electronics Division, R&D duties centered in the Design Branch. The branch was divided along functional lines into sections (e.g., radar systems, communications systems) each of which had design and development responsibilities in its specific area. A separate research coordination section managed overall coordination of the R&D program. The section maintained records of all R&D projects within the branch, assigned work to the laboratories, and established priorities of development.[3]

EXHIBIT I-4
Bureau of Ships 1946



Bureau of Aeronautics

The Bureau of Aeronautics was responsible for the design, construction, test, procurement, production, maintenance, and repair of naval aircraft and related aeronautical material. Exhibit I-5 indicates that the R&D responsibility was assigned to an Assistant Chief for Research, Development, and Engineering. The Assistant Chief (RD&E) had direct control over the formulation and execution of all programs dealing with the research, design, development, engineering, and testing of all types of naval aircraft and their related components. The R&D organization provided for separate divisions for piloted aircraft and pilotless aircraft (guided missiles), each of which was subdivided according to a particular type or class of vehicle or weapons (e.g., fighter aircraft, attack aircraft, etc.). Each subunit then exercised continuing engineering coordination and control through all stages of design, development, test, and production. In addition to these so-called class desks, there were a number of component divisions that dealt with specific technical elements (e.g., power plants, armament). The interaction of the disparate divisions was coordinated by project officers who headed teams comprised of representatives of the various groups.[4]

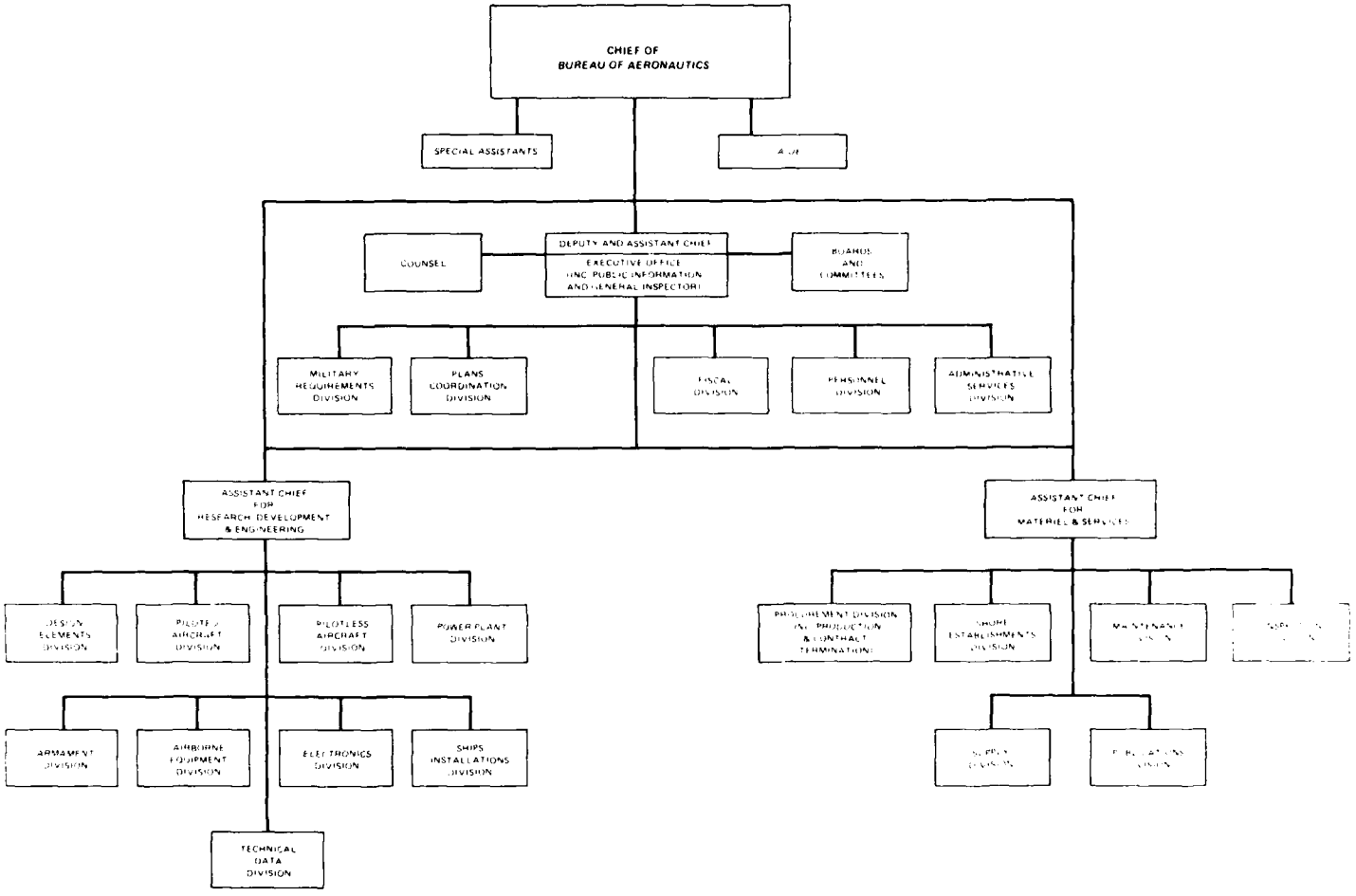
R&D Responsibilities of the Assistant Secretary of the Navy (Air)

The Assistant Secretary of the Navy (Air) was the senior official in the office of the Secretary with responsibility for R&D. As such, he had authority for promulgating policies and procedures concerning the "correlation and programming of research, experimental test and evaluation activities." The ASN(Air) also represented the Navy on various boards and agencies including those dealing specifically with R&D. Another important aspect of the R&D responsibility of ASN(Air) was that of overseeing the Office of Research and Inventions.[5]

R&D Role of the Office of the Chief of Naval Operations

The organization for R&D in the Office of the Chief of Naval Operations was an outgrowth of forces beginning in the latter stages of World War II. During the war, there were two separate headquarters organizations reporting to Admiral E.J. King: the Office of the Commander in Chief, United States Fleet (COMINCH) and the Office of the Chief of Naval Operations (OPNAV). The former had the responsibility for preparation, readiness, and logistic support of the fleet, while the latter had overall command of the Operating Forces. Within the COMINCH organization was a Readiness Division, which had the duty of determining fleet requirements. On March 25, 1944 a Research and Development Section was organized in the Readiness Division to coordinate the generation of requirements. A year later the Section was renamed New Weapons, Research, and Development.[6]

EXHIBIT 1-5
Bureau of Aeronautics 1946



Following the war, the Office of the Chief of Naval Operations reorganized and absorbed the COMINCH Organization. Established in OPNAV were Deputy Chiefs of Naval Operations for Personnel, Administration, Logistics, Operations, and Special Weapons. A Deputy Chief for Air had been appointed during the war and remained essentially the same in the realigned organization. The Office of the Deputy Chief for Operations [DCNO(Operations)] assumed control for the Operational and Readiness Divisions of the old COMINCH Organization. A new Operational Readiness Division (OP-34) was organized under an Assistant Chief of Naval Operations to monitor new weapons research and development.* The Operational Readiness Division also had responsibility for the Operational Evaluation Group and the Operational Development Force. The latter organization was a product of the war and had responsibility for evaluating new weapons, equipment, and methods proposed for introduction into the fleet.[7]

The Deputy Chiefs for Operations, Air, and Special Weapons each had responsibility for generating requirements statements within their respective warfare areas. Initially, however, there was some question as to who held responsibility in OPNAV for coordinating the R&D requirements of the three Deputy Chiefs. In early 1946 a New Developments Progress Section was established under the DCNO(Logistics) for the ostensible purpose of directing and coordinating the logistics phases of new developments. Later in the year a Temporary New Development Board was organized in the Office of DCNO (Operations). The Board studied new development programs in the bureaus and recommended priority of development projects to the CNO so that the program submitted for inclusion in the FY48 budget would constitute a single coordinated package. The Board completed its work in 4 months and dissolved. Its functions were absorbed by the Operational Readiness Division. While the Temporary New Development Board had primarily concerned itself with program review, its location under the DCNO(Operations) strengthened that office's claim of overall responsibility for coordinating R&D requirements. The claim was solidified with the establishment in November 1946 of a New Development and Operational Readiness Branch within the Operational Readiness Division. The creation of this new office ensured that all future R&D coordinating responsibility would be under the aegis of the DCNO(Operations). At the same time that the coordination question was settled, the Office of the DCNO(Special Weapons) was disestablished. Its R&D functions were split between DCNO(Operations) and DCNO(Air).[8]

ESTABLISHING THE OFFICE OF NAVAL RESEARCH

The concept of a Navy office dedicated to scientific research dated back to work undertaken during World War II by the National Defense Research Council (NDRC) and the Office of Scientific Research and Development (OSRD). The latter organization

* The Operational Readiness Division was originally designated as a section, but the organizational terminology was revised and it was renamed a division

served as the focus for the national defense R&D effort during World War II and was administered centrally through the Executive Office of the President.[9]

With the termination of hostilities, OSRD began to phase out its operations. Because of its demonstrated success and the strategic importance of research and development, there was agreement in the scientific community that some form of national research organization should be created. There was no consensus in Congress as to what form the proposed agency should take. The Secretary of the Navy, ever mindful of the value of R&D, moved to create a scientific organization within the Navy to fulfill the Navy's research needs and to complement the national science effort. On May 19, 1945, Secretary of the Navy James Forrestal issued a directive establishing the Office of Research and Inventions (OR&I) within the executive office of the Secretary to coordinate the Navy's research effort.[10]

OR&I represented a merger of a number of existing Navy organizations including the Office of Patents and Inventions, the Office of Coordinator of Research and Development, and two laboratories, the Naval Research Laboratory and the Special Devices Center. It was under the direction of a Chief of Research and Inventions who had authority to coordinate all naval research, experimental, and test activities. The primary mission of the office was to stimulate research efforts in the bureaus and to assume cognizance in those areas of interest to more than one bureau. One of the major undertakings of OR&I was to establish an extensive research program at various scientific institutions, including universities, independent research laboratories, and in private industry. These projects were primarily aimed at developing close ties between the scientific community and the Navy and to extending the bank of fundamental scientific knowledge in areas of interest to the Navy.[11]

The Office of Research and Inventions had been established under the authority of the War Powers Act, which was to expire 6 months after the cessation of hostilities. To continue this effort, it was necessary to have Congress pass a new law providing for a naval research institution. There was also a desire to give the research office a status similar to the bureaus, all of which were created by congressional enactment. Accordingly, a bill was introduced in Congress to create an Office of Naval Research (ONR). The original bill intended to centralize all naval research in the Office of Naval Research, but it ran into difficulties on several fronts. After successfully passing the House, the legislation encountered stiff opposition in the Senate Naval Affairs Committee. The Committee, at the behest of the material bureaus, dropped the clause giving ONR authority to control bureau research and substituted for it a more innocuous provision giving the scientific organization coordinating authority over bureau research programs. The Office of the Chief of Naval Operations also sought to restrict the power of ONR, largely because it wanted to bring research under military control with a Deputy Chief of Naval Operations for Research and Development. Despite such attempts to weaken the bill, it became law on 1 August 1946.[12]

The senior official in ONR was the Chief of Naval Research. He reported to the Secretary via ASN(Air) and had assigned responsibility for; "encouraging, promoting, planning, initiating and coordinating naval research." In executing this responsibility, the Chief of Naval Research was to carry out the following functions:

- Serve as principal advisor to the Secretary of the Navy in all research matters
- Keep the Chief of Naval Operations informed of findings, trends, and potentialities in research
- Act as principal representative of the Navy for research
- Collaborate with the CNO and the bureaus in the formulation of the principal development programs
- Supervise, administer, and control all activities related to patents, inventions, trademarks, and similar matters.[13]

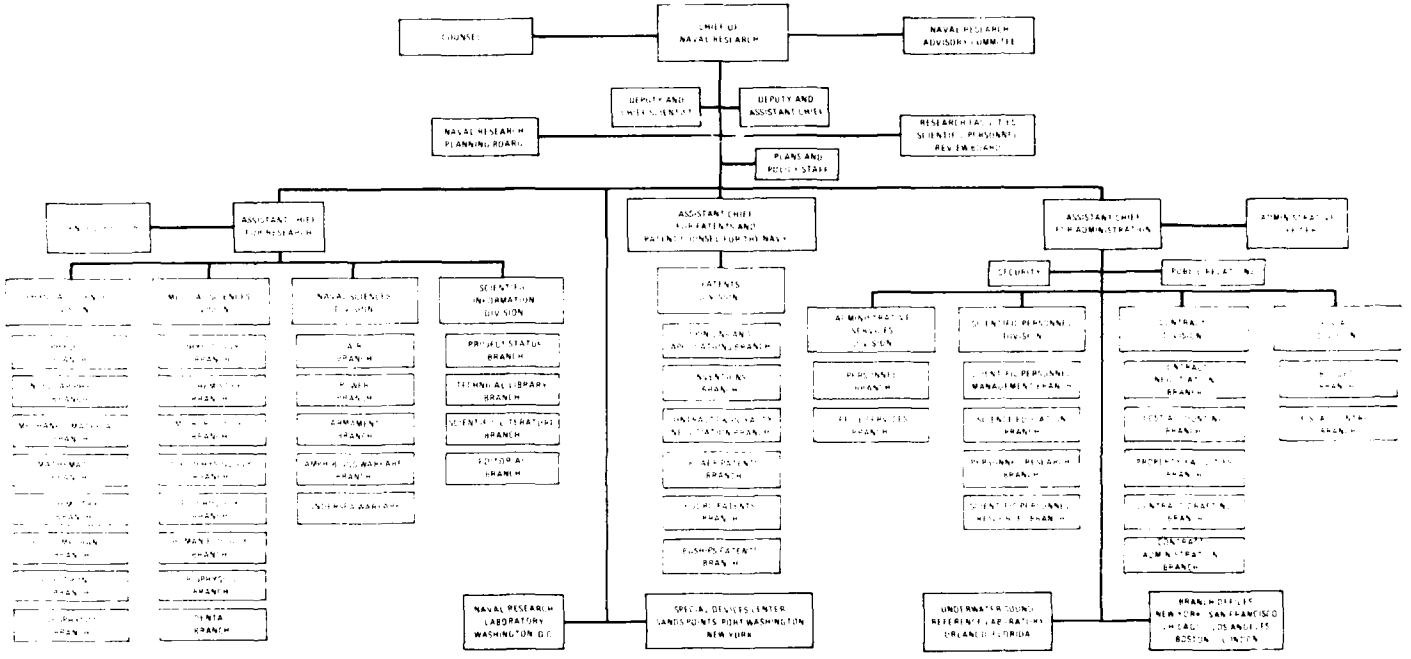
As depicted in Exhibit I-6, there were three research divisions reporting to the Assistant Chief for Research. In addition, the laboratory facilities, which were previously under the jurisdiction of the Office of Research and Inventions, were transferred to the new organization.

Initially the objective of ONR was to increase the scientific and technical potential of the Navy by directing its programs toward:

- Supplying new knowledge needed to support existing development projects and to point the way to future efforts
- Alleviating the displacement of research facilities and the shortage of scientific manpower
- Reorienting laboratories from wartime development work to long term basic and applied research
- Meeting the demands for new training methods and devices to instruct a greater number of men in more complicated operations in less time.[14]

The bill creating the Office of Naval Research included a provision for a Naval Research Advisory Committee. The Committee, appointed by the Secretary, was to consult with and advise the Chief of Naval Operations and the Chief of Naval Research on matters of research and development. It represented one aspect of a concentrated effort

EXHIBIT I-6
Office of Naval Research 1946



on the part of the Navy to bring in eminent scientists from private industry and universities on a part-time basis to help decide what type of projects to support.

JOINT RESEARCH AND DEVELOPMENT BOARD

Interservice cooperation prior to World War II had been accomplished on an informal basis and through formal committees appointed by the secretaries of the two Services (e.g., Army Navy Munitions Board). During the war these committees continued operations under aegis of the Joint Chiefs of Staff. The war also prompted the establishment of new governmental organizations which required coordination with the two Services. One such organization was the Office of Scientific Research and Development.

The pattern of interservice cooperation in scientific matters continued after the dissolution of the OSRD through the auspices of the Joint Research and Development Board (JRDB). The Board, established by the Secretaries of War and Navy in mid-1946, was to coordinate all R&D activities of common interest to the Services. It consisted of five men, two appointed by each of the Services and a chairman chosen by agreement of the two secretaries and removable by either. Much of the actual work of the JRDB was performed by committees and panels organized along the same tripartite lines as the Board itself. These committees gathered information concerning Army and Navy R&D programs and made recommendations as to specific Service responsibility. The Board operated on a basis of voluntary cooperation with each of the Services maintaining its independence of action.[15]

A second organization, the Aeronautical Board, had responsibility for R&D in the field of aviation. Established in 1916, the mission of this board was to ensure "complete cooperation and coordination in the development of aviation of the Army and the Navy." The organization was similar in most respects to the JRDB. Of the eight committees assisting the formal Board, one was devoted to R&D. Its duties were to provide information to the Services concerning aviation developments and to recommend to the Board any actions necessary to foster research and prevent unnecessary duplication. As was the case with the JRDB, the decisions made by the Aeronautical Board were not binding on the Services.[16]

Notes to Chapter 1

1. Department of the Navy, General Order 230, January 12, 1946.

2. Bureau of Ordnance, *An Analytical Report of the Bureau of Ordnance Guided Missile Program* (Washington, D.C., 1950), pp. 21-30.

3. Julius Furer, *Administration of the Navy Department in World War II* (Department of the Navy, Washington, D.C., 1959), pp. 225, 230-231; Personal Interviews; Bureau of Ships, *Organization of the Bureau of Ships* (Washington, D.C., 1945), Section F, pp. 1-4.

4. Bureau of Aeronautics, *Manual of Organization* (Washington, D.C., 1946), NAVAER-2425, pp. 52-53.

5. Department of the Navy, Office of Management Engineer, *The United States Navy: A Description of its Functional Organization* (Washington, D.C., 1947), NAVEXOS P-435, pp. 5-7.

6. Furer, *Administration of the Navy*, pp. 153-154.

7. Chief of Naval Operations, "Annual Report, 1946" (Washington, D.C., 1947), pp. 3-5, 33, 48 (Typescript Copy); Furer, *Administration of the Navy*, pp. 168-170.

8. Chief of Naval Operations, "Annual Report, 1947" (Washington, D.C., 1948), pp. 20-21 (Typescript Copy).

9. Department of the Navy, "History of the Office of Scientific Research and Development" (Washington, D.C., 1961), p. 5 (Unpublished ms).

10. Directive of the Secretary of the Navy, Subject: Office of Research and Inventions, May 19, 1945.

11. Secretary of the Navy, *Annual Report, 1946* (Washington, D.C., 1947), pp. 30-31, 68-71.

12. U.S. Congress, House, Committee on Naval Affairs, *Sundry Legislation Affecting the Naval Establishment, 1946* (Washington, D.C., 1947), pp. 2835-2843; P.L. 79-588; H.G. Bowen, *Ships, Machinery, and Mossbacks* (Princeton, N.J., 1954), pp. 350-352.

13. P.L. 79-588.

14. Secretary of the Navy, *Annual Report, 1946*, p. 70.

15. President's Scientific Research Board, *Administration for Research: Science and Public Policy (Steelman Report)*, Vol. III (Washington, D.C., 1947), pp. 15-17.

16. Bureau of Aeronautics, *Manual of Organization of the Bureau of Aeronautics* (Washington, D.C., 1946), pp. 57-58.

CHAPTER 2

OFFICE OF THE SECRETARY OF DEFENSE 1947-1958

Prior to the passage of the National Security Act of 1947, interservice relationships were based largely on voluntary agreement. The National Security Act introduced a new party to the military establishment, the Secretary of Defense, and began the formal process of more closely integrating the work of the three Services. Over the course of the next decade, certain modifications were made that considerably enlarged the activity and authority of the Office of the Secretary of Defense. In the case of research and development, new authority was translated into a much more active involvement in the decision-making process. This chapter examines those changes in the R&D function of the Office of the Secretary of Defense that had a direct impact on the management of R&D in the Navy in the years 1947-1958.

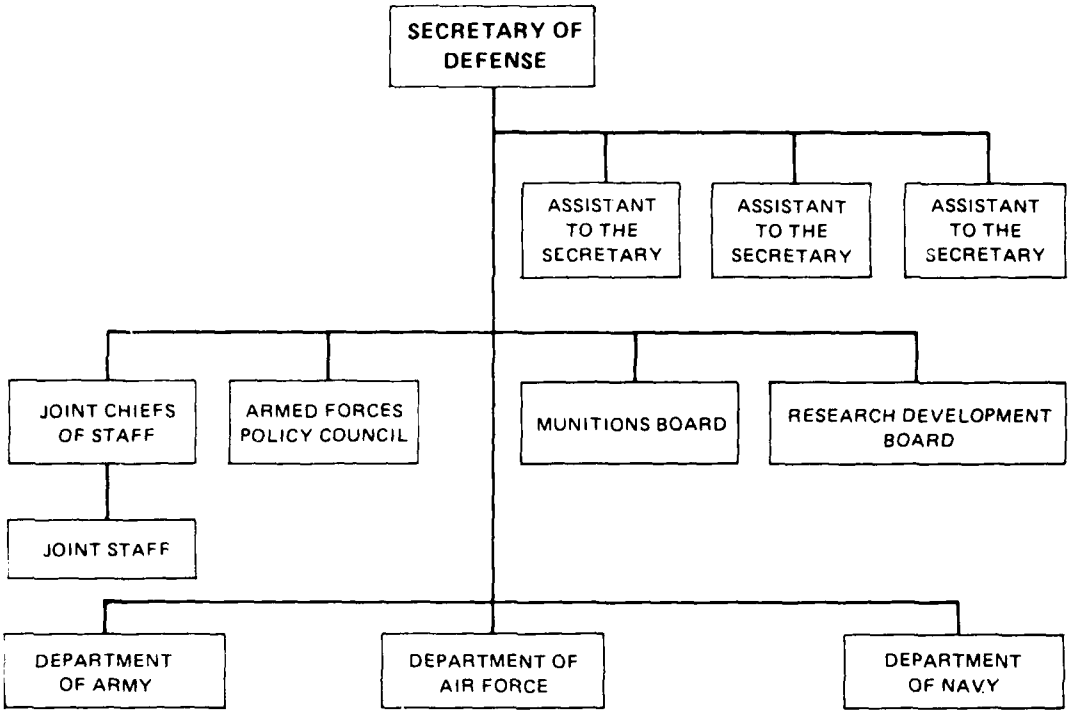
THE NATIONAL SECURITY ACT OF 1947

The pattern of interservice cooperation developed after World War II represented an interim step toward the larger goal of a more formal and integrated defense organization. Disagreements concerning the form and substance of that organization prevented settlement of the issue in 1946, but in the following year a compromise was reached. The result was the congressional passage on 26 July 1947 of the National Security Act. The legislation created a National Military Establishment consisting of the Departments of the Army and Navy plus a third branch, the Department of the Air Force, together with certain other agencies that had been organized as a part of the Act (see Exhibit I-7). General management responsibility for the federated agency was assigned to the newly designated Secretary of Defense, while internal administration of the Services was left to the individual military departments. Integration of effort was to be accomplished by various coordinating agencies and boards.[1]

The Secretary of Defense was to serve as the principal advisor to the President for all matters relating to national security. The authority conferred upon the Secretary to execute this function was, however, couched in vague and ambiguous terms. According to the law, the Secretary was to formulate "general policies and programs for the National Military Establishment" and to exercise "general direction, authority and control." With respect to R&D, the act was slightly more specific. The Secretary was to take "appropriate steps" to eliminate "unnecessary duplication" in research.

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EXHIBIT I-7
National Military Establishment 1947

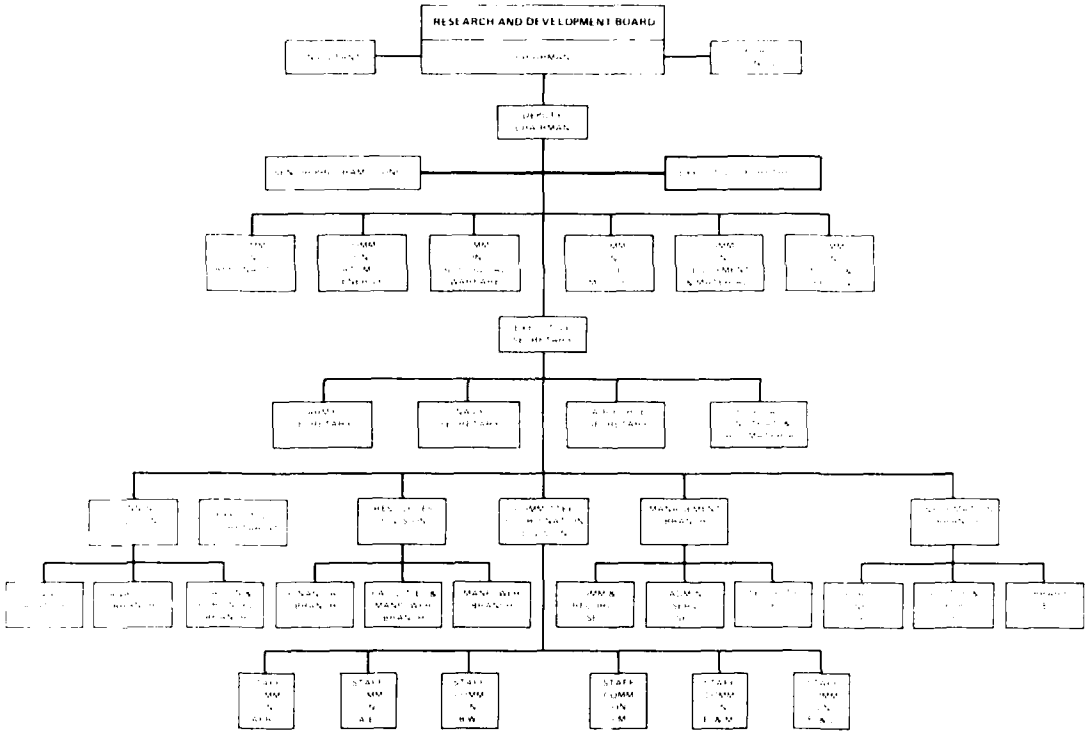


THE RESEARCH AND DEVELOPMENT BOARD

To assist the newly designated Secretary of Defense in the execution of his R&D responsibility, the National Security Act created the Research and Development Board (RDB) (see Exhibit I-8). The RDB closely resembled its predecessor, the Joint Research and Development Board, and assumed all of its functions. There was, however, the potential for a significant increase in the Board's authority. In addition to the coordinating and allocating functions previously performed by the JRDB, the new Board was charged with the responsibility for preparing a complete integrated program of research and development for the National Military Establishment and of advising the Joint Chiefs of Staff on the interaction of current research with national strategy.[2]

The RDB entered its official existence on September 30, 1947, but it wasn't until December 18 that Secretary of Defense James Forrestal signed the directive delineating its official duties and functions. The Board consisted of a civilian chairman, Dr. Vannevar Bush, appointed by the President, and two representatives from each of the three Services. Service representation was considered a significant qualification for Board membership,

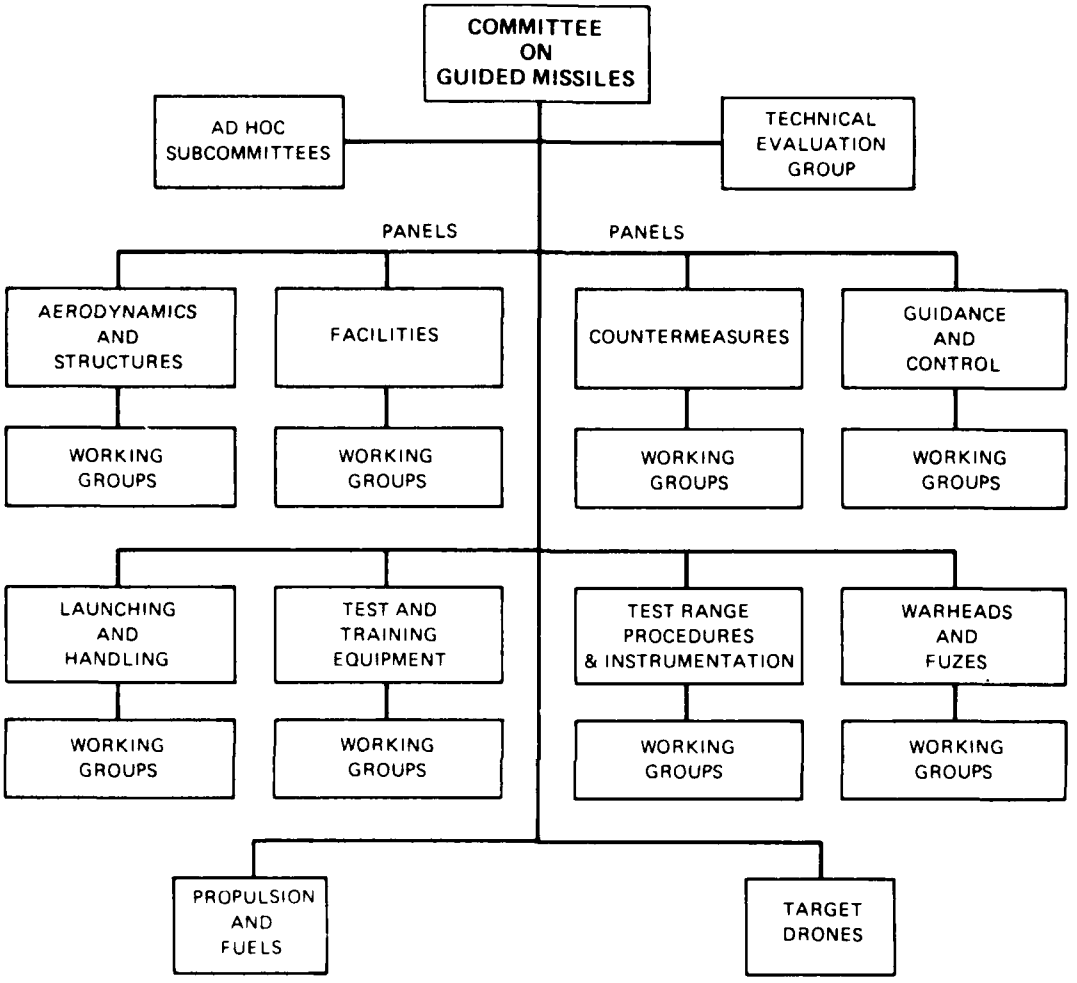
EXHIBIT I-8
Research and Development Board 1947



since it was the intent of the National Security Act to give the operators a direct voice in policymaking. The Chairman of the Board served as the representative of the Secretary. He had no authority in his own right and functioned primarily as a mediator of interservice disputes. Only in cases of extreme disagreement were R&D decisions made directly by the Secretary.[3]

The RDB operated primarily through a network of committees composed of senior civilian scientists and officers of general or flag rank. The committees organized along broad subject areas such as atomic energy or guided missiles, and in many cases they divided into panels and subpanels to cover various aspects of the particular field (see Exhibit I-9). The committees were assisted in their work by industrial and academic consultants. Much of the coordination between the three Services was accomplished at the panel level through detailed presentation and discussion of ongoing R&D programs.[4]

EXHIBIT I-9
Committee on Guided Missiles,
Research and Development Board 1947



The third major component in the RDB organization was the Secretariat. Under the direction of the Executive Secretary and his Deputy, the membership included flag or general officer level representatives of the three Service Secretaries and the directors of the planning and programs divis of the military departments. Its functions were to execute and implement the actions of the Board and to handle the day-to-day administrative details.

The intent of the RDB was to devise an overall plan by which the R&D programs of the three Services could be evaluated. The plan was stated in terms of military objectives

to be realized, technical characteristics of future weapons systems to meet those objectives, and priorities of development. It was reviewed continuously and revised on an annual basis. In reviewing the programs of the three Services, the RDB sought to determine how the individual Service R&D programs fit into the overall plan and whether all parts of the overall plan were adequately covered. It also sought to ascertain the level of effort placed on particular programs and to identify any unnecessary duplication of programs and projects.[5]

The RDB could not be considered a planning agency in the classic sense. Decisions were reached on the basis of negotiation between the Services. Moreover, the Board had neither the manpower nor the facilities to oversee the complex process of plan development. In practice, the responsibility for making plans rested with the Services; the function of the RDB was to examine such plans and either accept or modify them in light of the needs of the entire defense community.[6]

In its first year in action, the Board was unable to prepare an overall R&D plan. It was, however, able to assemble an interim program which served as a guide for the military departments. The inability of the Board to establish a unified R&D plan was perceived by Secretary of Defense Forrestal to be symptomatic of its inherent weakness. The Board had no control whatsoever over the R&D budgets of the three Services, which made it impossible to order shifts in emphasis or priority. There was also concern over alleged parochialism on the part of the military members of the Board who tended to place the interests of their own departments over those of the RDB. Secretary Forrestal recognized the Board's weaknesses and went so far as to say that attainment of the RDB objective of "unified and integrated research and development programs" would be difficult to realize without "extensive alterations in the board mechanism."[7]

At the same time the RDB was starting operations, certain other developments occurred in the National Military Establishment which had a direct bearing on the management of R&D in the Navy. On August 1, 1948, the Aeronautical Board was dissolved. One result of the National Security Act had been the assignment of most of the Board's functions to other agencies including its R&D responsibility. In addition, a Weapon System Evaluation Group was organized under the sponsorship of the Joint Chiefs of Staff and the RDB. The group served in an advisory capacity, providing independent analyses of current and future weapons systems.[8]

1949 AMENDMENTS TO THE NATIONAL SECURITY ACT

The National Security Act had been in operation for less than two years when problems began to appear. The Commission on Organization of the Executive Branch, chaired by Herbert Hoover, concluded that the National Military Establishment suffered

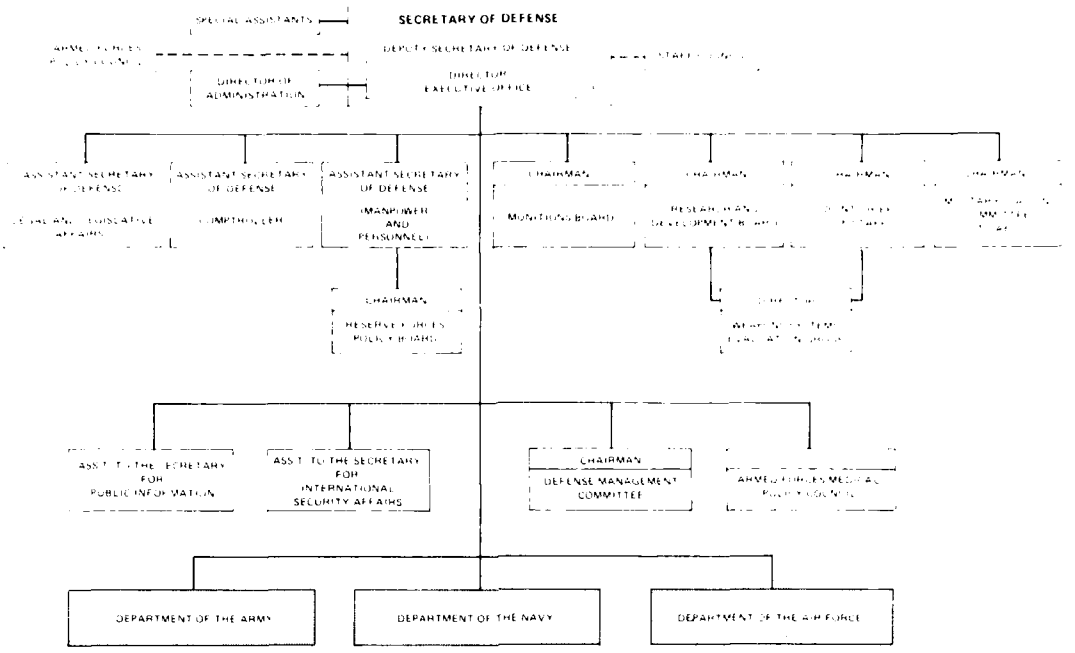
from a lack of central authority and direction. The commission noted that the authority of the Secretary of Defense was weak and restricted by limitations in the 1947 Act. For example, the Secretary could not hire or fire subordinates, except on his immediate staff, which in itself was small. Another problem the commission observed was the ability of the Service Secretaries to resist the direction of the Secretary of Defense and appeal directly to the President or the Director of the Budget in cases dealing with budgetary matters. In making its recommendations to the President, the Hoover Commission maintained that the only way to secure efficiency, economy, and accountability in the National Military Establishment was through centralization of authority and control in the President and the Secretary of Defense.[9]

The Hoover Commission reasoned that the nonvoting status of the Chairman of the RDB seriously limited the Board's ability to make definitive decisions for the Secretary of Defense. For example, in the case of guided missiles, the RDB resolved the difficult question of cognizance by permitting each of the military departments to undertake R&D projects in the area. The first department to develop a suitable weapon would then be awarded cognizance. A budget ceiling placed on expenditures for FY49 forced the Board to make a decision. In the absence of mission guidelines from the Joint Chiefs of Staff (JCS), the Board split along Service lines and recommended a division of available funds among the three Services. The conclusion of the Hoover Commission was that if the Chairman of the RDB had the power of decision, then more definitive policies could be determined.[10]

The recommendations of the Hoover Commission were an important factor in the congressional decision to amend the National Security Act. The legislation that passed Congress on August 10, 1949, provided for the following sweeping changes:

- The National Military Establishment was given the title of executive department and renamed the Department of Defense (see Exhibit I-10).
- The Services lost their executive branch status and were redesignated military departments.
- The staffing of the Secretary of Defense and Joint Chiefs of Staff was substantially increased.
- Firm budget controls were established for the Defense Department.
- The Chairman of the RDB was given the power of decision.
- The composition of the RDB changed with the requirement that one of the two members from each of the military departments be an assistant or under secretary.[11]

EXHIBIT I-10
Department of Defense 1949



In a separate but related action in 1950, the Secretary of Defense appointed a Director of Guided Missiles to provide him with advice concerning the coordination of activities dealing with the research, development, and production of guided missiles. The director also acted as a consultant in the field to the Chairman of the RDB.[12]

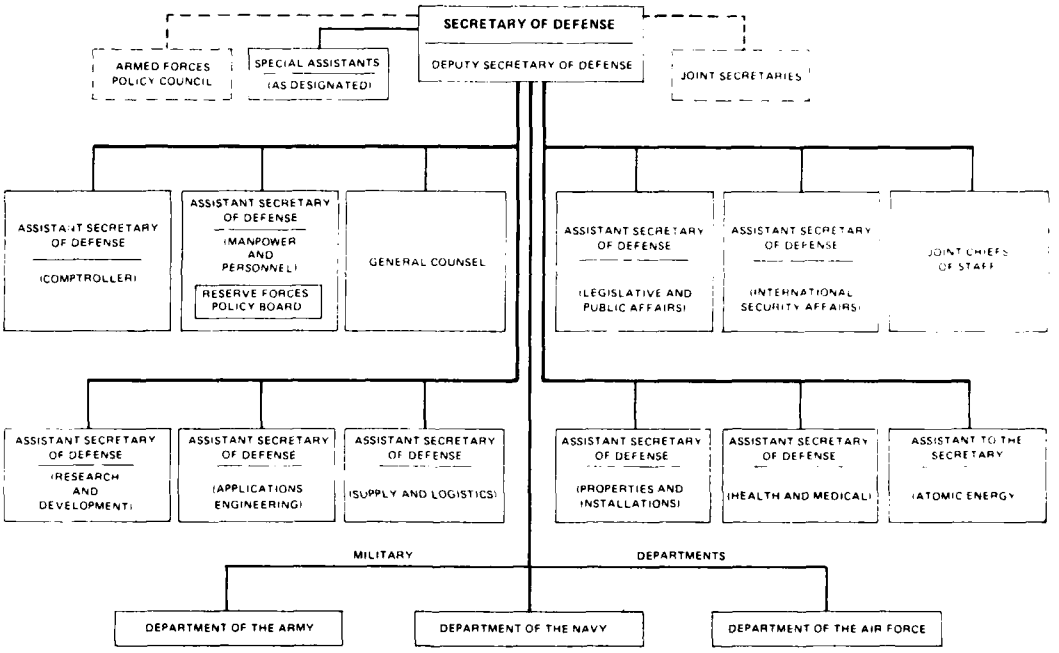
ORGANIZATIONAL CHANGES 1953-1958

The modifications made in the structure of the RDB enabled it to more successfully execute the Secretary's mandate to coordinate the R&D programs of the Services. There were an increasing number of critics, however, who maintained that the Board's unwieldy organization was incapable of the task of bringing together a truly integrated defense R&D program. The Board, opponents claimed, reviewed R&D programs in such "small packages" that it was almost overwhelmed by the enormity of the task. There was also the criticism that the Board's committees were dominated by uniformed personnel who devoted too much of their time to improvements in exisiting weapons systems and not enough to outside scientific development. To remedy alleged defects, critics proposed a complete reorganization of defense R&D, centering on the elimination of the Board and its committees, designation of a civilian director for military R&D, and a much greater reliance on nonmilitary resources.[13]

Reorganization Plan Six 1953

During the Presidential campaign of 1952, candidate Dwight Eisenhower indicated that if elected he would appoint a commission to study the Department of Defense. After his election, Eisenhower appointed a committee to study defense organization and designated Nelson Rockefeller as its chairman. The Rockefeller Committee report, presented to the President in April 1953, served as the basis for Reorganization Plan Six.[14] Unlike the earlier reorganization act, Plan Six was submitted under a provision in the 1949 NSA Amendments which permitted presidential reorganization proposals to become law after a specified time without congressional concurrence, provided neither the House nor the Senate passed resolutions to the contrary. While there were attempts made to block the plan, they fell far short, and the reorganization was implemented (see Exhibit I-11).[15]

EXHIBIT I-11
Department of Defense 1953



Reorganization Plan Six focused on three major objectives: strengthened civilian control, improved strategic planning, and effectiveness with economy. To strengthen civilian control, the plan recommended clarification of the level of authority within the Department of Defense so that there would be no doubt that the Secretary of Defense had ultimate authority for his department. In other words, no function within the Department of Defense was to be exercised independently of the Secretary of Defense.

The principle of Service autonomy was diluted by the requirement that the military department secretaries were to function as "operating managers" and principal advisors to the Secretary of Defense. Another change in the planning responsibility was accomplished by removing the organization of the Joint Chiefs of Staff from the chain of command and strengthening the JCS administrative machinery. Removal from the chain of command left no doubt that the basic role of the organization was planning.[16]

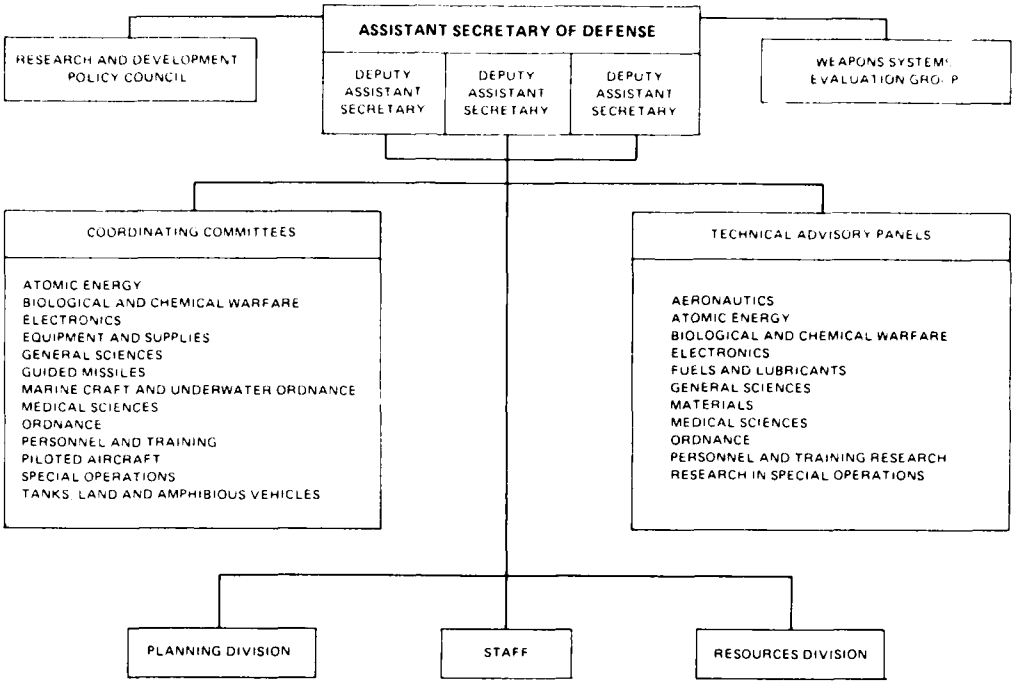
The third objective, "maximum effectiveness at minimum cost," had a direct bearing on the organization of defense R&D. To further this objective, the Rockefeller Committee recommended the establishment of six assistant secretaries including separate offices for research and development and applications engineering. The assistant secretaries were to serve as advisors to the Secretary of Defense in the fields of policy and determination of standards and to provide him with the information necessary to make decisions. They had no direct line authority in their own right. The assistant secretaries for research and development and applications engineering were to replace the RDB which the Rockefeller Committee believed to be handicapped in executing its responsibilities by virtue of its "rigidity" of membership and the "complicated administrative mechanisms inherent in the board-type structure."[17]

Assistant Secretary of Defense (Research and Development)

The implementation of Reorganization Plan Six began on June 30, 1953. By the end of the year, most of the new organization was in place. A directive issued by the Secretary of Defense in November 1953 outlined the responsibilities of the ASD(R&D), and the central task remained the preparation of an integrated R&D program for the Department of Defense. The directive further spelled out the working relationship between ASD(R&D) and ASD(AE). "Where advanced technology or new art is involved, such as new electronic systems, research and development, as referred to herein, begins with basic and exploratory research and extends through successful laboratory and engineering field test of prototypes, together with systems analysis and evaluation incidental to such development. Where the art is well established, or parallels closely civil design, such as heavy mechanical equipment in general, research and development will be limited to exploratory work through the research or breadboard model phases and cognizance will pass to applications engineering at the stage where design of a military item can be undertaken."[18]

The organization of the ASD(R&D) comprised three main elements: the R&D Policy Council, coordinating committees, and technical advisory panels (see Exhibit I-12). The Research and Development Policy Council considered policies and procedures in the field of military research and development and served as an advisory board for ASD(R&D). The council was chaired by ASD(R&D) and included the senior civilian and military

EXHIBIT I-12
Office of the Assistant Secretary of Defense
(Research and Development) 1953



officers with cognizance for R&D from each of three military departments. Major problems in the areas of funding, personnel, organization, methods, and procedures in the coordination of defense R&D occupied the attention of the council.[19]

The coordinating committees represented a carryover from the RDB. The R&D program was divided into 13 areas with a coordinating committee established to cover each of the designated areas. The committees consisted of representatives of the three military departments, and the ASD(R&D); their primary objective was to plan and coordinate R&D programs in their respective areas. In accomplishing the broad task of coordination, the committees reviewed plans and programs to ensure adequacy and proper balance, interchanged R&D information among the departments, reached agreement on methods to achieve integration of effort, approved new projects and important changes in such projects prior to initiation, and advised ASD(R&D) on the need for funding R&D activities and facilities. The committees also considered the impact of military requirements on R&D activities, made efforts to encourage adoption of joint requirements where military needs were similar, and evaluated the adequacy of R&D programs in light of strategy, technological limitations and advances, and threats to the national security.[20]

The advisory panels were constituted along technological lines. The R&D program was divided into technological sectors and a panel organized for each area. Unlike the committees, the panels were made up of consultants from the scientific and technical community who were selected on the basis of their expertise in that area. Panels acted separately and with the assistance of subpanels. A panel studied the area of R&D assigned to it and advised the cognizant coordinating committees and the ASD(R&D) of its findings.

There were two additional organizations that operated under the aegis of the ASD(R&D). The Weapon System Evaluation Group continued in its role of providing the Joint Chiefs of Staff with operational analysis for strategic planning, but now reported adminstratively to the ASD(R&D). In addition, the Assistant Secretary had a permanent office staff which provided assistance and support to the advisory panels and coordinating committees.

The change from the RDB to the ASD(R&D) was most evident in the control and coordination of the defense R&D dollar. While Congress appropriated R&D funds to the military departments, the obligation of those funds by the departments was subject to the approval of the Secretary of Defense. The ASD(R&D) could recommend withholding of funds for any development project. In the preparation of the budget, the ASD(R&D) role was much more pronounced than that of the RDB which operated largely without authority. The R&D Policy Council established guidelines for the preparation of the R&D budget 18 months prior to its submission. The R&D coordinating committees reviewed the military departments' budgets 6 to 12 months in advance and also approved the departments' plans for obligation of available funds, subject to review by the OSD Comptroller and the Bureau of the Budget.[21]

Assistant Secretary of Defense (Applications Engineering)

The organization of the Assistant Secretary of Defense for Applications Engineering [ASD(AE)] was patterned directly after that of the ASD(R&D). This can be explained by the recognized need for close cooperation between the two offices and because the organization for ASD(R&D) had been completed first. Accordingly, ASD(AE) established a policy council and coordinating committees; advisory panels, however, were not created.

ASD(AE) had the responsibility of preparing policies and procedures for the Secretary of Defense that would ensure that military weapons and systems would meet the objectives of applications engineering. Applications engineering was defined by directive to be "the attainment of minimum kinds of weapon and equipment systems, with least cost, effort, and time, all in proper balance." The field of applications engineering varied

on different projects depending on the state of the art in the individual project. In borderline cases, the responsibility for determining cognizance would be decided by the ASD(R&D) and the ASD(AE).[22]

As the operations of the ASD(AE) began to unfold, it became apparent that its functions were more closely aligned with the ASD(R&D) than had previously been appreciated. Research and development and applications engineering for weapons systems proved not to be mutually exclusive processes but instead complementary functions at each successive stage. The recognition of this fact came in a DOD directive issued in late 1954 clarifying the relationships of ASD(R&D) and ASD(AE). The major change involved the merger of those coordinating committees of greatest common interest to the two offices: ordnance, guided missiles, aircraft, and electronics. Responsibility for managing these committees was determined on the basis of functional area. Another change involved the dissolution of the Applications Engineering Policy Council and the addition of the ASD(AE) and his deputy to the R&D Policy Council. Finally, in cases where the objectives of the two offices appeared to be at variance, the requirements of ASD(R&D) were to take precedence.[23]

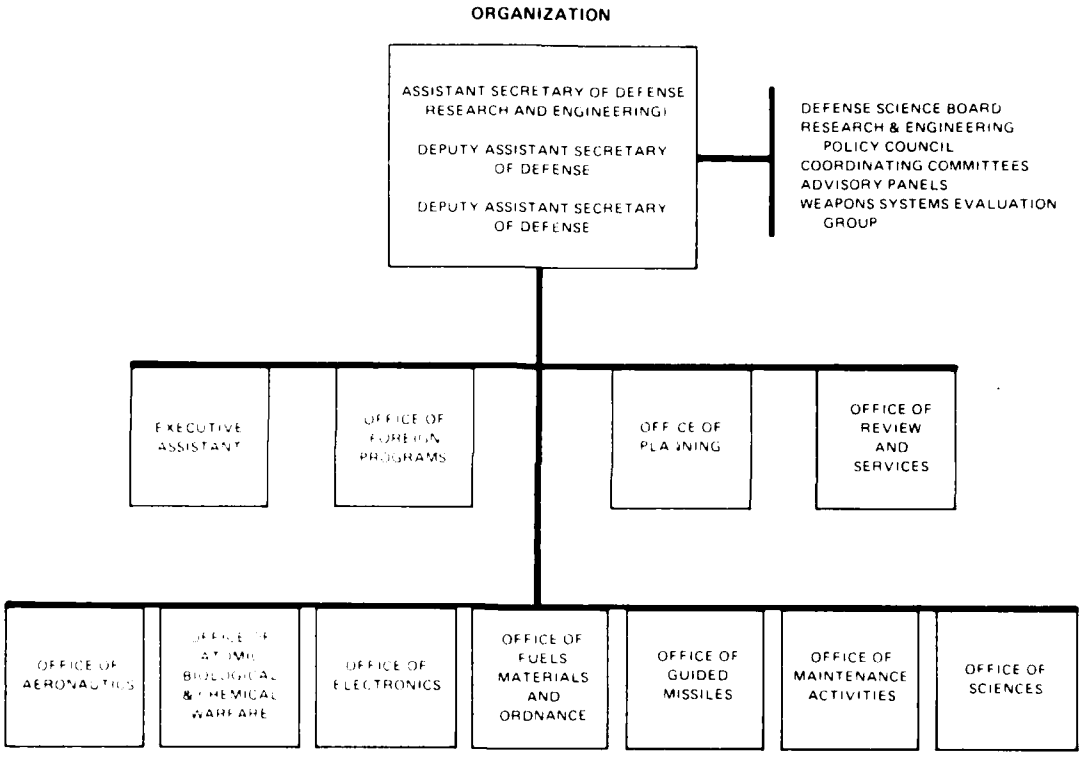
Assistant Secretary of Defense (Research and Engineering)

The clarification of responsibilities between the two assistant secretaries served a useful purpose, but it did not satisfactorily resolve the problem. The subcommittee on research and development of the Second Hoover Commission found that the basic division of the research and engineering function was at fault. The subcommittee agreed with the Rockefeller Committee's view that there existed a need for coordination and leadership for the area of applications engineering at the Department of Defense level, but it did not believe that the establishment of an Assistant Secretary for Applications Engineering was the appropriate response. The R&D and applications engineering functions were too closely linked and did not warrant separate organizational status. The committee recommended that the effectiveness of the two offices be reviewed by the Secretary of Defense. The subcommittee anticipated that such a review would find the existing organization inadequate to the task and, therefore, proposed integrating the two departments under a single assistant secretary for research and engineering.[24]

The subcommittee recommendation for the merger of the ASD(R&D) and ASD(AE) had been made in early 1955, but it wasn't until March 1957 that the proposal was effected. The offices of the two assistant secretaries were disestablished and a new Assistant Secretary of Defense for Research and Engineering was created (see Exhibit I-13). The responsibilities of the ASD(R&E) closely approximated those of its predecessors. Advising and assisting the Secretary of Defense in the development of R&D policies and plans remained the major function. Organizationally, however, there was a distinct

change. The policy council, coordinating committees, and advisory panels were all retained, but additionally, the permament staff of the ASD(R&E) was significantly expanded. The revamped organization now included a number of functional and administrative offices which provided advice and staff support to the ASD(R&E). In some cases, the offices went one step further and developed and recommended policies and procedures in their given subject areas. The expansion in staff resulted in an increase in the authority of ASD(R&E).[25]

EXHIBIT I-13
Office of the Assistant Secretary of Defense (Research and Engineering) 1957



Defense Science Board

In addition to the merger of the two assistant secretaries, there were other changes involving the R&D responsibility of the Office of the Secretary of Defense. In 1956 the Defense Science Board was established as a standing advisory committee reporting directly to the ASD(R&D). The mission of the Board was to advise the Secretary of Defense and ASD(R&D) on research and development and to provide long-range guidance to the Department of Defense. Also in the same year, a Special Assistant for Guided

Missiles was named. Following the launching of Sputnik in mid-1957, Secretary of Defense Neil McElroy upgraded responsibility for guided missiles to the level of director. The Director of Guided Missiles reported directly to the Secretary of Defense and had responsibility for overall coordination of the guided missile programs for the three military departments.[26]

Advanced Research Projects Agency

Sputnik also played a role in the decision of Secretary McElroy to establish a research organization in the Department of Defense for all antimissile and satellite technology. The creation of the Advanced Research Projects Agency (ARPA) in 1958 represented the culmination of several years of effort among certain elements in the scientific community who had pursued the objective of a civilian-oriented research organization in the Department of Defense. The new science organization was responsible for research not identified with a specific military requirement, research relating to the primary function of two or more Services, and research the Secretary of Defense determined to be best handled by an agency outside the military departments. In the case of ballistic missile defense, ARPA's purview extended to the development phase as well. ARPA also had a nonmilitary space role, but it was only briefly held and subsequently transferred to the new National Aeronautics and Space Administration.[27]

The establishment of ARPA was a major milestone in the centralization of authority for R&D. For the first time OSD was directly involved in the actual implementation of prospective weapons programs.

Notes to Chapter 2

1. P.L. 80-253.
2. Ibid.; Secretary of Defense, *Annual Report 1947-48* (Washington, D.C., 1948), p. 121.
3. John C. Ries, *The Management of Defense* (Baltimore, Md., 1964), pp. 96-98.
4. Secretary of Defense, *Annual Report, 1947-1948*, (Washington, D.C., 1948), pp. 121-24.
5. Ibid., pp. 124-25.
6. Ries, *Management of Defense*, p. 98.
7. Secretary of Defense, *Annual Report, 1947-48*, p. 120.
8. Secretary of Defense, *Semiannual Report, July 1 - December 31, 1949* (Washington, D.C., 1950), p. 79.
9. Commission on Organization of the Executive Branch, *The Hoover Commission Report*, (New York, 1949), pp. 187-88, 194-95.

10. Ibid., pp. 194-95.

11. P.L. 81-216.

12. Secretary of Defense, *Semiannual Report January 1 - June 30, 1950* (Washington, D.C., 1951), p. 48.

13. U.S. Congress, House Committee on Government Operations, *Report on Organization and Adminstration of Military R&D Programs*, Report No. 2618, 83rd Congress, 2nd Session, (Washington, D.C., 1954), pp. 65-67.

14. U.S. Congress, Senate Committee on Armed Services, *Report of the Rockefeller Committee on Department of Defense Organization*, 83rd Congress, 1st Session, (Washington, D.C., 1953), (Hereinafter cited as *Rockefeller Committee Report*).

15. Theodore W. Bauer and Harry B. Yoshpe, *Defense Organization and Management*, (Washington, D.C., 1971), pp. 20-21.

16. Harry B. Yoshpe and Stanley Falk, *Organization for National Security*, (Washington, D.C., 1963), p. 36.

17. *Rockefeller Committee Report*, p. 12; *U.S. Statutes at Law*, Vol. 67, p. 638.

18. DOD Directive 5128.7, Subject: Responsibilities of the Assistant Secretary of Defense (Research and Development), November 12, 1953.

19. U.S. Congress, House Committee on Government Operations, *Hearings on Organization and Administration of the Military Research and Development Programs*, 83rd Congress, 2nd Session, (Washington, D.C., 1954), p. 13.

20. Ibid.

21. Commission on Organization of the Executive Branch of the Government, *Subcommittee Report on Research Activities of the Department of Defense and Defense Related Agencies*, (Washington, D.C., 1955), pp. 14-15.

22. DOD Directive 5129.1, Subject: Responsibilities of the Assistant Secretary of Defense (Applications Engineering), December 8, 1953.

23. Commission on Organization of the Executive Branch of the Government, *Subcommittee Report on Research Activities*, pp. 17-18.

24. Ibid., pp. 18-19.

25. "Assistant Secretary of Defense Research and Engineering," *Armed Forces Management*, III, No. 12, (November 1957), 36-38.

26. Yoshpe and Falk, *Organization for National Security*, p. 40.

27. National Science Foundation, *Federal Organization for Scientific Activities, 1962*, (Washington, D.C., 1962), NSF, 62-37, pp. 121-22.

CHAPTER 3

NAVY DEPARTMENT 1947-1958

While the Research and Development Board undoubtedly influenced the Navy R&D planning process (described in Part III) and encouraged the establishment of points of contact for R&D matters in the Office of the Chief of Naval Operations, Navy Department independence and authority remained essentially intact through 1949. The 1949 Amendments to the National Security Act, however, significantly altered the military environment by reducing the status of the military departments within the newly established Department of Defense and conferring upon the Secretary of Defense unqualified authority, direction, and control of defense policy. The practical effect of the Amendments was the beginning of a gradual transfer of power from the Services to the Secretary of Defense.

The subsequent centralization of authority in OSD had a pronounced influence on Navy R&D organization. As decisionmaking flowed upward from the RDB to the Assistant Secretary of Defense (R&D) and later to the Assistant Secretary of Defense (R&E), there developed a recognition among senior Navy officials that more specialized R&D organizations were required to interface directly with their OSD counterparts. Consequently, R&D staffs began to appear at critical points in the Navy organization.

In most instances, organizational change in the Navy was preceded by internal management study. These studies varied in scope and degree of formality. In the context of this review, the following were the most noteworthy of the studies undertaken:

- *Low Board* (1950): Under the aegis of Vice Admiral F. S. Low, a comprehensive study was undertaken of undersea warfare.

- *Gates Committee* (1954): In response to Reorganization Plan Six, Under Secretary of the Navy Thomas Gates chaired a Navy-wide study to develop methods to strengthen management and improve efficiency and economy.

- *Libby Board* (1956): Conducted by Vice Admiral R.E. Libby, the Libby Board examined the adequacy of the bureau system of organization.

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In response to these studies as well as to administrative actions taken in the normal course of events, noteworthy changes were made in the R&D roles and organizational relationships in the Navy Department. These changes are described in the sections below.

OFFICE OF THE CHIEF OF NAVAL OPERATIONS

The R&D function of the Office of the Chief of Naval Operations underwent a significant transformation in the years 1947-1958, largely as a result of the emphasis on interservice cooperation exerted initially by the RDB and later by the Assistant Secretary of Defense (R&D). In deliberations with personnel from the Office of the Secretary of Defense, it was most important that a unified Navy position be presented. Since the Office of the Chief of Naval Operations had responsibility for determining requirements and served as the principal interface with the RDB and ASD(R&D), it was only natural that it take steps to strengthen the organizational role of R&D.

Research and Development Review Board

On December 19, 1947, one day after the RDB received formal notification of its duties and functions, a New Development Board was established in OPNAV to review the development program of the bureaus and offices and to recommend priorities of development to the Chief of Naval Operations. The Board membership consisted of representatives from the so-called warfare desks in the Offices of the Deputy Chiefs of Naval Operations for Air and Operations. It represented a permanent commitment on the part of the Chief of Naval Operations to review development programs prior to their submission to higher authority.[1]

The New Development Board was in operation for less than 5 months when it was renamed the Navy Research and Development Review Board and its membership expanded to include the Chief of Naval Research. The Board served as the focal point for coordinating Planning Objectives, Operational Requirements, and establishing R&D priorities as well as consolidating and reviewing the annual Navy R&D program budget. The only major personnel change involving the Board came in 1950 when the Assistant Chief of Naval Operations (Readiness) replaced the Director of Fleet Readiness as chairman. Much of the day-to-day work of the Board was performed by the Deputy R&D Review Board which consisted of the principal assistants to the members of the parent organization.

The R&D Review Board made its recommendations to the Chief of Naval Operations who had responsibility for reviewing and approving them prior to submission to the Office of the Secretary of the Navy. CNO was assisted in this task by the CNO Advisory Board (CAB). The CAB, established in 1951, advised and made recommendations with

respect to naval programs and their budgetary implications. Its active members included the bureau chiefs and the Chief of Naval Research.[2]

In early 1950 a comprehensive study of undersea warfare, conducted by Vice Admiral F.S. Low, led to a significant development in the Office of the Chief of Naval Operations. The Low Board report, issued in April 1950, recommended that each of the established warfare desks designate an R&D billet with responsibility for formulating comprehensive requirements in its program area and that all such requirements be reviewed, coordinated, and promulgated by a single agency under the aegis of the Assistant Chief of Naval Operations for Readiness. The recommendation was implemented in November of the same year. A New Developments and Operational Evaluation Division was established under the Deputy Chief of Naval Operations (Operations) and the proposed R&D billets organized in each of the warfare desks. In addition to its principal task of coordination, the new division assisted the Navy Research and Development Review Board by preparing its agenda, providing required information, and promulgating its decisions. It also had responsibility within the Office of the Chief of Naval Operations for coordinating the R&D budget and for maintaining liaison with the appropriate bureaus, offices, and boards to integrate the R&D plan with the budgetary programs of the remainder of the department.[3] Exhibit I-14 illustrates the organizational framework in which the New Developments and Operational Evaluation Division functioned as of 1951.

Assistant Chief of Naval Operations (R&D)

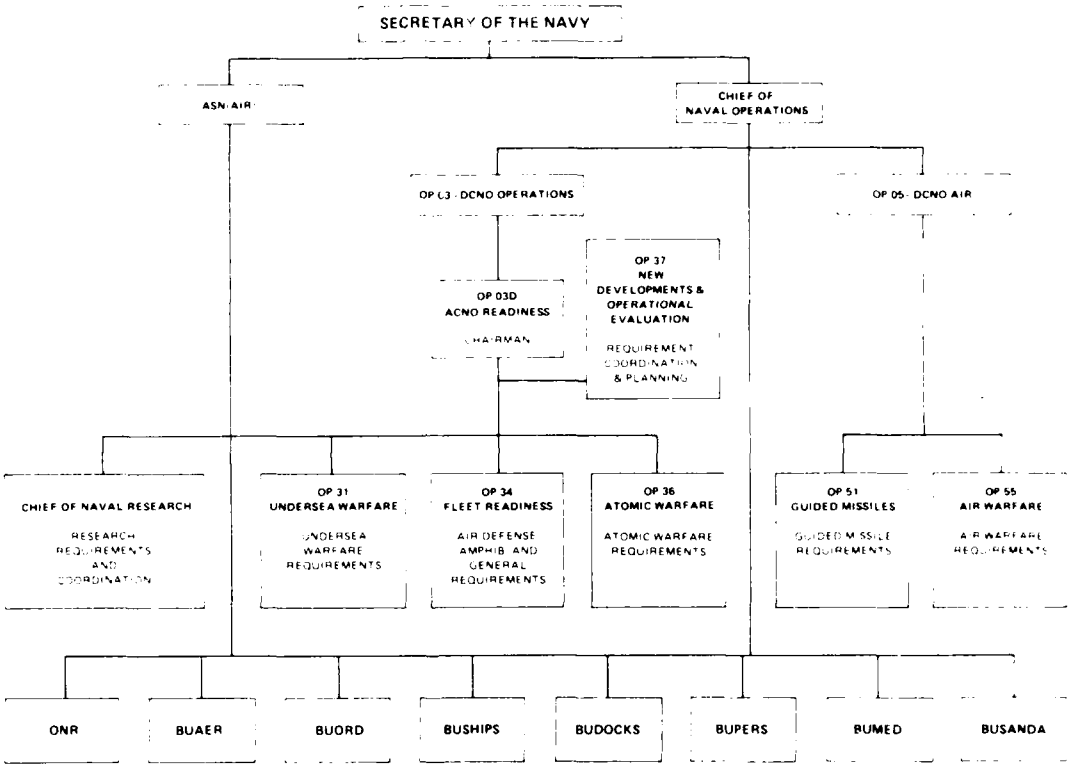
In 1954 the Office of the Chief of Naval Operations underwent an internal reorganization as part of an effort to improve R&D planning. One element of change involved the establishment of Operational Requirements and New Development Planning Branches in each of the warfare divisions. The branches determined the new development needs of the fleet and formulated, reviewed, and revised Operational Requirements for research and development programs. The Director of the New Developments and Operational Evaluation Division continued to function as the principal staff for R&D in OPNAV.*

Two years later, the Libby Board made a thorough examination of the organization of the Office of the Chief of Naval Operations and its responsiveness to the development of new weapons systems. Of particular concern to the Board was the division of R&D planning responsibilities among the warfare desks. The Board noted that each of the warfare desks tended to approach system developments from the restricted point of view of its own category of warfare. This led to complications in the review and screening of

* Another element of change in the OPNAV internal reorganization of 1954 was the redesignation of the DCNO (Operations) as the DCNO(Fleet Operations and Readiness).

Operational Requirements prepared by those desks, since no one office had the responsibility or staff to look at the overall picture. Ordinarily, the Deputy Navy R&D Review Board performed the review function, but the Libby Board concluded that neither the adjunct nor the Director of the New Developments and Operational Evaluation Division, who served as support to the R&D Review Board, was adequately staffed to review on a Navy-wide systems basis the Operational Requirements.

EXHIBIT I-14
Coordination of Navy Research and Development 1951



*TAKEN FROM OPNAV INSTRUCTION 03900.1 25 MAY 1951 SUBJECT: COORDINATION OF THE NAVY R&D PROGRAM

To correct the situation, the Board proposed the elimination of the adjunct board and the New Developments and Operational Evaluation Division, and the creation of an Assistant Chief of Naval Operations for New Developments and Operational Evaluation. The new office was to include a Systems Development Planning Division that would work closely with the bureaus, offices, and warfare desks to develop weapons systems plans. Such plans would relate weapons systems to the entire field of naval warfare. The new

office would also serve to coordinate the work of the warfare desks and interact with the Assistant Chief of Naval Operations for Fleet Readiness to ensure that new developments were coordinated with existing weapons systems.[4]

On 12 July 1956 Chief of Naval Operations Arleigh Burke announced the establishment of an Assistant Chief of Naval Operations for Research and Development. The ACNO(R&D) served as the principal advisor and assistant to the DCNO (Fleet Operations and Readiness). He assumed the staff of the previously disestablished ACNO (Fleet Readiness) and also that of the New Development Operational Evaluation Division, which was not formally disbanded until June 1957. Specific R&D functions assigned to ACNO(R&D) included:

- Preparation of the R&D objectives which, when approved, formed the R&D Plan
- Coordination of the work of the other Offices of the Chief of Naval Operations in the field of R&D
- Review, preparation, and approval of the Operational Requirements and Development Characteristics prepared by the cognizant OPNAV divisions
- Formulation of guidelines for preparation of the annual Navy R&D program.[5]

The ACNO(R&D) remained under the DCNO (Fleet Operations and Readiness) until 3 January 1958; thereafter he reported to the Vice Chief of Naval Operations. In addition to changing the reporting relationship of the ACNO(R&D), there was also an increase in authority of the office. ACNO(R&D) retained responsibility for reviewing the R&D programs submitted by the bureaus and offices to ensure a coordinated program, but now also was charged with the responsibility of recommending to the CNO which R&D programs should be included in the budget.[6]

The elevation of the R&D responsibility in OPNAV reflected the growing involvement taken by that office in R&D affairs. The separation of R&D from operations represented a major break with previous policy and aroused concern that R&D was rapidly becoming an entity unto itself. The change was, however, merely a prelude toward the larger goal of a separate Deputy Chief for Research and Development.[7]

THE MATERIAL BUREAUS

While the 1949 Amendments to the National Security Act reduced the organizational status of the Department of the Navy which in turn translated into a loss of prestige for the material bureaus, there were relatively few changes in bureau R&D

organization until the mid-1950's. In 1955 the Chief of Naval Operations decided to set up a special organization to manage the development of a fleet ballistic missile. The resulting Special Projects Office represented a dramatic departure from past practice and was symptomatic of the growing interest in systems integration and program management. It also led to a number of changes in the organization and management of Navy R&D at the bureau level, which are discussed in the paragraphs below.

Bureau of Ordnance

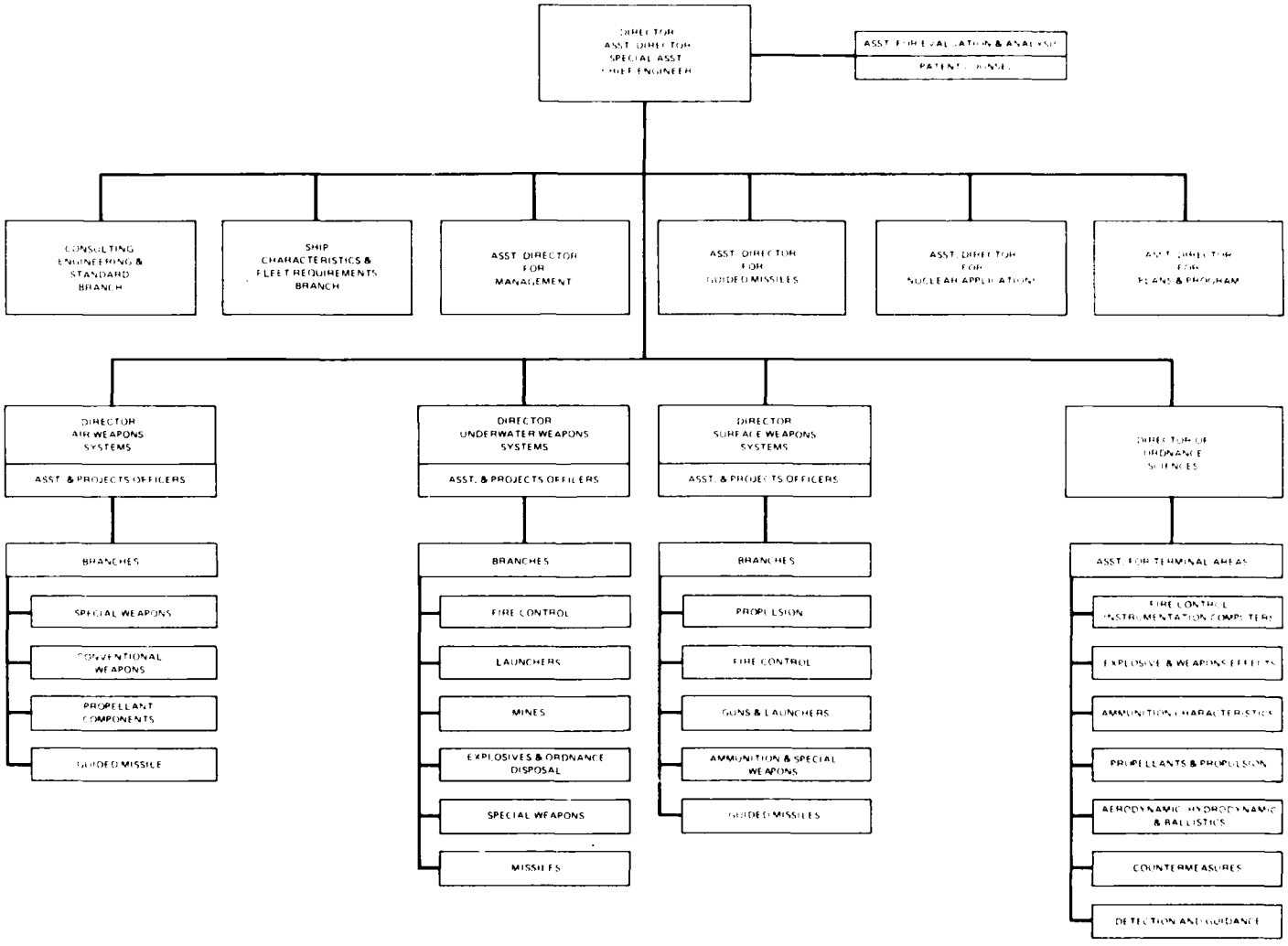
The R&D Division of the Bureau of Ordnance remained stable until 1950 at which time it established a planning, coordination, and analysis branch (Code Rex). The branch performed a number of important functions for the Assistant Chief (R&D) including: preparation of the annual R&D program submission to the RDB; preparation of the R&D portion of the BuOrd budget; liaison with other bureaus, military departments, and the RDB with respect to R&D planning; and coordination of R&D projects to ensure that such projects were in accordance with the overall program.[8]

BuOrd completed a comprehensive realignment of the Research and Development Division in February 1956. The objective of the reorganization was to strengthen the weapons system concept by making basic changes at the operating level. As illustrated in Exhibit I-15, the realignment significantly altered the old organization in which ten technical branches were loosely coordinated by six system directors. As a result of the reorganization, operating responsibilities were divided into four units, each administered by a systems director who had full authority and control over his organization. In addition, the Assistant Chief (R&D) created the billet of Assistant Director for Plans and Programs to assist him in supervising long-range research and development plans.[9]

Bureau of Ships

As indicated in Chapter 1, research and development programs in the Bureau of Ships were divided between the Ships and Electronics Divisions. In 1948, BuShips appointed Assistant Chiefs for Ships and Electronics which had the effect of upgrading each of the organizations by one echelon. For example, the Research and Standards Branch became the Research Division. In August 1948 the Research Division was expanded to include the Nuclear Power Branch. The Nuclear Power Branch occupied a unique status in the bureau, owing to the commitment of BuShips and the Navy to the development of a nuclear-powered submarine and because of the close relationship with the Atomic Energy Commission.[10]

EXHIBIT I-15
Bureau of Ordnance, R&D Division 1956



In 1949, the Research Division was reassigned from the Assistant Chief for Ships to a newly established Assistant Chief for R&D. Under the Assistant Chief (R&D) were four major divisions: R&D planning, material development, applied science, and nuclear power. The Assistant Chief (R&D) had responsibility for preparing the R&D budget, assigning priorities to R&D projects, and maintaining technical and management control over the bureau's laboratories.[11]

In 1954 the Bureau of Ships underwent a major reorganization which resulted in the creation of Assistant Chiefs for Ship Design and Research and Ship Building and Fleet Maintenance. The ostensible purpose of the merger of the design and R&D functions was to accommodate the interests of the incumbent of the new office. R&D reverted back to the status of a separate assistant chief when the original incumbent changed billets.[12]

The 1954 reorganization had no effect on the R&D responsibilities of the Assistant Chief for Electronics. The primary R&D agency under the Assistant Chief was the Electronics Design and Development Division. It consisted of six operating branches which administered much of the actual research and development, while an assistant director for planning and programming provided staff support.[13]

Bureau of Aeronautics

The organization for research and development in the Bureau of Aeronautics underwent two significant changes during the era. The first change proved to be temporary. On January 8, 1947 the Research, Design, and Engineering Group was split into a Research and Development Group and a Design Engineering Group. The R&D Group was nominally responsible for all research, development, and experimental work performed by the bureau; it had four subdivisions, only one of which had a solid R&D orientation. The Design and Engineering Group was responsible for final design, engineering and testing of aircraft, guided missiles, and ship, airborne, and associated aeronautical equipment. It was comprised of the remaining elements of the original Research and Development and Engineering Division including the so-called class desks and component groups.

The organizational division of R&D lasted until 1950 at which point the two groups were merged into a single Research and Development Group. An Assistant Chief for Research and Development functioned as the head of the merged group, which now had responsibility for all phases of the R&D process, as well as design/engineering cognizance throughout the life cycle of BuAer systems.[14]

Later BuAer reorganized with the objective of improving program management. In 1955 the Chief of the bureau established an Assistant Chief for Plans and Programs to

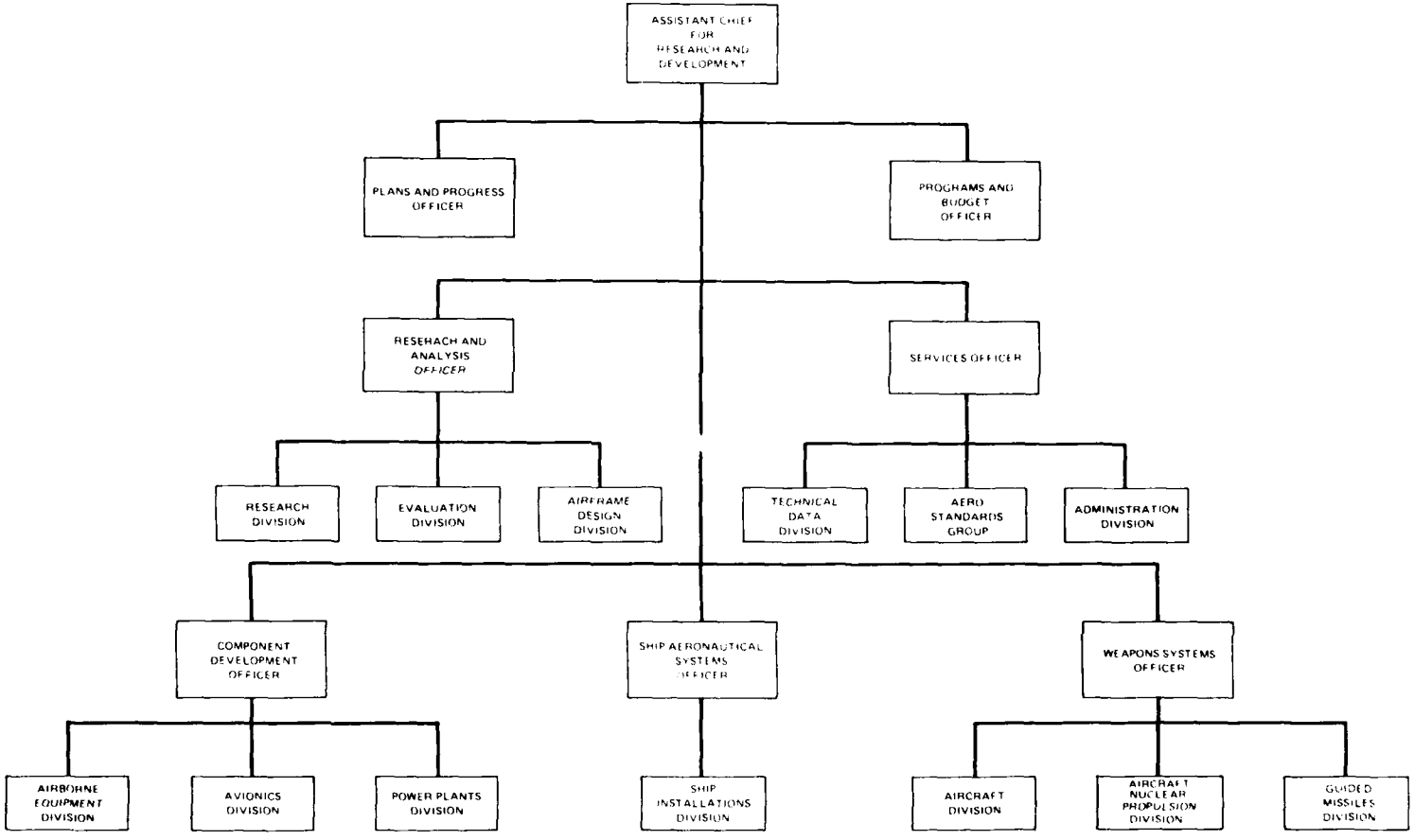
coordinate and direct the implementation of all bureau programs from the bureau staff level. The internal organization of the Office of the Assistant Chief for Plans and Programs resembled the "class desk" arrangement by virtue of the fact that separate units were charged with responsibility for various classes of aircraft and guided missiles. An officer was assigned by the Chief of BuAer to direct each unit and coordinate overall project management from inception to conclusion. In practice, the principal concern of these so-called program managers was the transition to production, and they assumed an active management role only in the production phase.[15]

The following year Deputy Secretary of Defense Reuben Robertson formed a committee to study aircraft development. The committee was of the opinion that stronger program management could bring about significant improvements in the weapons acquisition cycle. After examining the Air Force and Navy approaches to program management, the committee concluded that project control in the Navy was both submerged and incomplete. To remedy the situation, it recommended clarifying the role of the class desk officer. In August 1956 BuAer reorganized its R&D Group to make it more compatible with program management concepts (see Exhibit I-16). The class desks divisions for aircraft, guided missiles, and aircraft nuclear propulsion were regrouped under a Weapons Systems Officer. BuAer also established program managers for each of the major weapons programs. The program managers were given extended tours of duty and made a part of the Plans and Programs Group. The number of program managers initially appointed was small (six), and it was not until 1958 that the new management was completely operational.[16]

Interbureau Technical Committees

Interbureau technical committees were organized by the chiefs of the three material bureaus to effect coordination in areas of interest to two or more of the bureaus. The committees consisted of technical representatives from the interested bureaus as well as nonvoting participants from the Office of the Chief of Naval Operations and the Office of Naval Research. Organization was dependent on the scope of the subject area. In cases where a subject area was broad, such as guided missiles, the committees were subdivided into smaller units dealing with more specialized subject areas such as guidance and control or propulsion. The committees reviewed the bureaus' R&D programs in their subject area and advised the appropriate chiefs regarding the status of the program, the degree of coordination required, and the desirability of continuing or discontinuing specific projects. They also established the arrangements for any general projects or contracts administered by the member bureaus. In cases where the Interbureau Technical Committees could not reach a consensus, the questions were presented to the Chief of Naval Operations for his comment and recommendation.[17]

EXHIBIT I-16
Bureau of Aeronautics, R&D Group 1956



Special Projects Office

The establishment of the Special Projects Office ranks as the most significant development in the period within the framework of the material bureaus. The decision to go outside the bureaus for development of the high-priority project stemmed in large part from the dispute over cognizance for guided missiles that dated back to the Second World War.

During the war years, Navy guided missile development was performed on a "crash" basis with a view toward rapid introduction into the fleet. The result was a guided missile program which grew with little regard to organizational consideration. Following the war, both the Bureaus of Aeronautics and Ordnance continued their R&D work in the field of guided missiles. Cognizance disputes inevitably arose which in some cases were settled amicably and in others resulted in the development of rival missiles.

After Secretary of Defense Charles Wilson made the decision to develop a fleet ballistic missile, the Navy faced a major problem. The Bureau of Ordnance claimed general responsibility for ship-launched missiles but displayed little initial enthusiasm for a naval ballistic missile. The Bureau of Aeronautics on the other hand was a vigorous proponent of the project and based its claim on successful development of a submarine launched missile, the Regulus I. Compounding the difficulty was a series of external events, including Soviet explosion of a hydrogen bomb, which made it imperative that a ballistic missile capability be secured on as accelerated a pace as possible. Ultimately, Chief of Naval Operations Arleigh Burke decided to bypass the traditional bureau structure and establish an organization comparable to that used in the Manhattan project to manage the ballistic missile program.[18]

The Special Projects Office was established on 5 December 1955 under the direction of then Rear Admiral William F. Raborn. The mission of the director was to design, develop, and achieve an initial and extended fleet ballistic missile operational capability on the tightest possible schedule. The office was supported administratively by the Bureau of Ordnance but reported directly to the highest echelons of the Navy. In staffing the office, Director Raborn was given virtual carte blanche to choose an initial cadre of technical and management personnel. He also was given "cradle-to-grave" responsibility for the entire development, and similar responsibilities were allocated at the subsystem level to the technical branch heads.[19]

Indicative of the unique nature of the Special Projects Office was its use of the Navy Management Fund. The fund provided for centralized budgeting, administration, and accounting of Polaris funds in a single organization. In effect, it gave the Special Projects Office complete financial authority for the entire system which enabled the office to plan for the program in its entirety, expedite funding requests and reprogramming actions, and eliminate problems of interbureau support.[20]

The Lead Bureau Concept

The decision to create the Special Projects Office to manage the Polaris project had profound consequences throughout the Navy. On the most basic level, it raised issues concerning the efficacy of the bureau system. In January 1956 Chief of Naval Operations Arleigh Burke ordered Vice Admiral R. E. Libby to critically examine the bureau system of organization as it related to the development of weapons systems. A principal objective of the study was to determine whether or not the bureaus were sufficiently responsive to the needs of the future.[21]

The Libby Board examined several different approaches to the organization of the material side of the Navy. A merger of the three material bureaus into a single technical bureau was considered as was the merger of the two parties in the cognizance dispute over guided missiles. In both cases the Board found that the potential advantages gained from merging were more than offset by the problems of managing such an enormous organization and by the probable "administrative layering." Other organizational patterns were studied including organization along warfare lines and around weapons systems. After surveying all of the possibilities, the Libby Board concluded that none of the alternatives discussed offered any decisive advantage over the current bureau organization.[22]

Given the premise that reorganization was not required, the Board then discussed the ad hoc management approach characterized by Polaris. There was no question that the designation of special offices was useful in certain extraordinary cases, but the Board found that the impact of such organizations upon the supporting activities was "serious," and could prove to be prohibitive if more than a few were organized. Specifically, the creation of special project offices tended to dilute the authority of the bureau, disrupt orderly planning, and divert personnel and facilities from other important projects. In light of these defects, the Board advised the ad hoc organizational approach be adopted in only the most exceptional circumstances.

The Libby Board's solution to the problem of development of new weapons systems involving more than one bureau was the "lead bureau concept." The lead bureau concept was the logical extension of a plan proposed by the Chief of Naval Operations in late 1955 to resolve the cognizance dispute between the Bureaus of Aeronautics and Ordnance. The plan involved the designation of a dominant or lead bureau to assume overall direction and responsibility for the technical prosecution of a weapons system project. The lead bureau would also coordinate the work of the subordinate bureaus.

From the point of view of the Libby Board, the lead bureau concept was attractive because it established clear-cut authority from the Chief of Naval Operations to the lead bureau and was not unduly disruptive of the routine of the bureaus. It was formally established as Navy policy on August 1, 1957.[23]

THE R&D FUNCTION OF ASN(AIR)

The R&D responsibility of the Office of the Secretary of the Navy was exercised throughout the period by the Assistant Secretary for Air. The only change in his authority in the early years came in 1952 when Congress passed into law a bill to "facilitate the performance of research and development." The law covered the implementation of certain contract procedures and established a reporting mechanism for contracts above a certain limit. There was also a provision authorizing the Service Secretaries to delegate any of the responsibility provided in the Act to either the Under Secretary or any of the Assistant Secretaries. Within the Navy, this additional duty was assigned to the Assistant Secretary for Air.[24]

In its analysis of the Office of the Assistant Secretary of the Navy for Air, the Gates Committee noted that the Assistant Secretary had collateral responsibilities in three functional areas (personnel, research and development, and aeronautical matters). In view of the disparate nature of the functions, the Committee recommended that the responsibilities be divided between two assistant secretaries. A separate secretary for personnel and reserve forces was offered as an alternative. The Committee agreed that the research and development and aeronautics functions should remain with the Assistant Secretary for Air.[25]

In a slightly different vein, the Gates Committee proposed that certain internal advisory committees be established to ensure more effective coordination between military and civilian executives. In accordance with the recommendation, the Secretary of the Navy appointed a number of committees, including one for research and development. The R&D Committee, organized in late 1954, acted in an advisory capacity for the Assistant Secretary of the Navy for Air. Its membership included the principal R&D officials in the Office of the Chief of Naval Operations and the bureaus; its duties involved the preparation of a technical R&D program in support of Navy and Marine Corps operational requirements and review of the proposed R&D budget. Because of its advisory nature, the impact of the R&D Committee varied significantly from Assistant Secretary to Assistant Secretary.[26]

Implementation of the Gates Committee's recommendation eased the workload of the Assistant Secretary of the Navy for Air, but a growing number of critics argued that research and development had grown to the point that a separate assistant secretary was required. In 1955, a subcommittee of the Second Hoover Commission found the Gates Committee recommendations inadequate and recommended the establishment of an Assistant Secretary for Research and Development. The subcommittee maintained that adminstration, organization, operation, and programming in research and development required the attention of a senior civilian official with a scientific and technical training and a background of experience in research and development and in its administration.[27]

The subject of a separate assistant secretary for R&D was broached the following year by the Libby Board. Both the Air Force and the Army had designated civilian executives for research and development as had the Secretary of Defense, and there was pressure on the Navy to do the same. The Libby Board, however, rejected the idea of a separate civilian R&D executive stating "the assignment of research and development to an assistant secretary who is also charged with broader management responsibilities returns dividends both in the research and development and in the production fields." The Board thought it a mistake to increase the number of assistant secretaries on account of the undesirable "layering" that would result. Research and development matters at the assistant secretary level, the Libby Board concluded, should remain the charge of the Assistant Secretary for Air.[28]

OFFICE OF NAVAL RESEARCH

Like the Assistant Secretary of the Navy for Air, the Office of Naval Research (ONR) was the subject of considerable discussion, much of it centering on the topic of coordination of R&D. The Gates Committee raised the salient question of the desirability of coordinating the R&D work of the bureaus and offices. Pressure was exerted on the Services both by Congress which feared unnecessary duplication of R&D programs and Defense Secretary Wilson who sought to improve efficiency and economy in the Defense Department. There was a measure of coordination in the Navy exercised by the Chief of Naval Research, but it extended only to research. Since development programs comprised 85 percent of R&D operations, a sizable vacuum allegedly existed.

The Gates Committee recognized the practical difficulties of separating applied research from development and therefore recommended that the authority of the Chief of Naval Research be expanded to include development. The move to give the responsibility for coordinating development programs to the Chief of Naval Research was also influenced by the fact that the position of coordinator was to be filled by a civilian and that the Office of Naval Research, rather than the Office of the Chief of Naval Operations, would provide a more compatible environment.[29]

Development Coordinator

The Gates Committee recommendation was adopted, and on June 24, 1954, the functions of the Chief of Naval Research (CNR) were restated to include formal responsibility for coordinating development programs. Procedures for development coordination were issued in April 1955, although the official position of Development Coordinator was not filled until some months later. Development coordination was defined to be the correlation of projects concerned with the design and construction of experimental equipment with current Navy Operational Requirements. Because of the magnitude of the task,

the initial step in implementing the coordination responsibility was to review projects in restricted functional areas. Coordination of bureau development programs was given top priority.[30]

The organization of the Office of Development Coordinator was three-tiered and reflected an emphasis on functional analyses. The three tiers represented warfare areas (anti-air, antisurface, antisubsurface operations), warfare systems (surveillance, command-control, logistics, nullification, maneuver-delivery), and technical systems (acoustics, infrared and magnetics, etc.). Each tier was staffed by coordinators who had responsibility for a specific area on a Navy-wide basis. Warfare area and warfare systems coordinators reported directly to the Development Coordinator while the technical systems coordinators reported to the Deputy Development Coordinator. Originally, the office was targeted for a total of 150 coordinators. The initial allotment was set at 50, but after 18 were hired, all further staffing was frozen.[31]

The task of coordinating development programs, as first conceived by the Development Coordinator, was to assess the interrelationships among technologies, warfare functions, and warfare areas in order to establish multidimensional criteria for program approval. The bureaus, however, were skeptical of "outside" attempts to manage their R&D programs and displayed considerable reluctance in cooperating with the Development Coordinator. The bureaus also suggested to the Libby Board that the authority of the Development Coordinator be limited. The Libby Board concurred and proposed that the directive defining the authority of the Development Coordinator be interpreted "to exclude intra-system coordination of system development."[32]

Because the Development Coordinator's approach to decisionmaking was weighed heavily in terms of operating parameters, there was some doubt within the research community whether the Office of Naval Research was the appropriate organization for the position of Development Coordinator. While there was no support as of 1956 for placing the Development Coordinator in the Office of the Chief of Naval Operations, sentiments were growing along those lines.[33]

Research Coordinator

In 1955, coordination of research was assigned to the Assistant Chief for Research and delegated to a Deputy Science Director for Coordination. The general objective of research coordination was to integrate the work of the different bureaus and offices into a balanced and effective program capable of supporting the Navy's research objectives. The methods utilized to achieve coordination included the creation of formal committees; informal gatherings of laboratory and bureau personnel; and study groups, conferences, and seminars. In most cases, coordination was accomplished on an informal basis as CNR sought to limit the numbers of formal committees.[34]

In 1958, ONR witnessed a resurgence in its research efforts as a result of concern generated by the launching of Sputnik. The renewed emphasis upon research together with the increasing complexity of scientific activities suggested to the CNR that a more determined approach was required for the coordination of research projects. At the same time, a conflict of interest became evident in the Office of the Assistant Chief for Research, who had the dual responsibility of coordinating the ONR and bureau research programs on one hand and directing the ONR research program on the other. Accordingly, the coordination authority was removed from the Deputy Assistant Chief for Research and assigned to a full-time Research Coordinator, reporting directly to the CNR.[35]

The Research Coordinator assisted the Chief of Naval Research in coordinating naval research and the research aspects of exploratory development programs conducted by the bureaus and offices of the Navy. He also established broad policy for coordinating basic and applied research, reviewed and evaluated basic and applied research programs, and formulated and promulgated research requirements.[36] One of his basic responsibilities was to document the ongoing research efforts within the Navy, including that portion being pursued by the bureaus. It was not a planning effort per se, but rather was intended to audit what was already underway and distribute the information throughout the R&D community. In 1963 the Office of the Research Coordinator was formally disestablished and the coordination responsibility returned to the Assistant Chief for Research.

Notes to Chapter 3

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3. VADM F. S. Low and RADM C. B. Morrisen, "Presentation to the Fifth Undersea Symposium" (Washington, D.C. May 15-16, 1950), NRC: CVW:0083, pp. 2-3; Chief of Naval Operations, *Organization Manual of the Chief of Naval Operations* (Washington, D.C., 1950), OPNAV P-02-100 (Rev. 11-50), p. 29.

4. Department of the Navy, *Report of the Board Convened by the Chief of Naval Operations to Study and Report Upon the Adequacy of the Bureau System of Organization* (hereinafter cited as *Libby Board*) (Washington, D.C., March 14, 1956), Section III, pp. 12-13.

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16. Ibid, pp. 33-36, 38-40; Memorandum from Chief of Bureau of Aeronautics to Assistant Secretary for Air, Subject: Robertson Committee Report - Submission of Initial Progress Report, October 22, 1956, pp. 7-9.

17. Bureau of Ordnance, *An Analytical Report of the Bureau of Ordnance Guided Missile Program*, pp. 26-27.

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21. Letter from Admiral A. Burke to Vice Admiral R.F. Libby, 115 P02, Subject: Precept Convening a Board to Study and Report Upon the Adequacy of the Bureau System of Organization, January 6, 1956.

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23. Ibid, Section III, pp. 22-24; SECNAV Instruction 3900.5, Subject: Adoption of Lead Bureau Method of System Development, August 1, 1957.

24. P. L. 82-562.

25. Department of the Navy, *Report of the Committee on the Organization of the Department of the Navy* (Washington, D.C., April 16, 1954), pp. 26-27.

26. SECNAV Instruction 5420.30A, Subject: Research and Development Committee, September 15, 1954.

27. Commission on Organization of the Executive Branch of the Government, *Subcommittee Report on Research Activities in the Department of Defense and Defense-Related Activities* (Washington, D.C., 1955), pp. 51-57.

28. *Libby Board*, Section III, pp. 27-28.

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32. Personal Interviews; Libby Board, Section III, pp. 19-21.

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CHAPTER 4

ORGANIZATIONAL CHANGE 1958-1959

The Soviet advances in space, the rising costs and complexities of weapons systems, and the rancorous interservice competition for dwindling defense dollars led President Eisenhower in January 1958 to request a further reorganization of the Department of Defense. In his State of the Union address, Eisenhower noted the impact of advanced technology on the current Department of Defense organization. He found that many of the new weapons systems defied Service classification as they "cut across all services, involved all services, and transcended all services at every stage from development to operation." The President's concern that sophisticated technology had ushered in a new era which the present defense organization was incapable of handling was further supported by the Rockefeller Panel.* In its study on defense organization, the Rockefeller Panel observed that the "explosive growth in technology created a situation in which R&D was a primary strategic concern." Because of its importance, the Panel recommended that the Secretary of Defense be given unequivocal authority for research, development, and procurement. Without such authority, the Panel feared that the role of the Secretary of Defense would remain an "essentially passive one of arbitrating disputes formulated elsewhere."[1]

DEPARTMENT OF DEFENSE REORGANIZATION ACT OF 1958

President Eisenhower submitted his reorganization proposal to Congress on April 3, 1958. Briefly, the plan called for strengthening the authority of the Secretary of Defense in the areas of strategic planning, military operations, and administration of the Department of Defense; greater use of the unified commands as operational instruments; and increased military unification of strategic and tactical planning.[2] The plan encountered stiff opposition from key elements in Congress who correctly perceived increases in the authority of the Secretary of Defense as a reduction in their own power and that of the three Services. Eventually a compromise was agreed upon, and the Reorganization Act was signed into law on August 6, 1958.

The 1958 Reorganization demonstrably enhanced the authority of the Secretary of Defense at the expense of the three military departments. The act stipulated that the Services no longer be separately administered but only separately organized; authority for

* In 1956 the Rockefeller Brothers Fund sponsored a special study project to define major problems and opportunities that would present themselves over the next 15 years.

direction and control of the military departments was now to be vested in the Secretary of Defense. Another aspect of the law which diminished the authority of the Services was the requirement that the Secretary of Defense assume responsibility for assignment and removal of forces to the unified and specified commands. The operational chain of command now completely bypassed the military departments flowing directly from the Secretary of Defense to the unified and specified commands. Finally, the legislation gave the Secretary of Defense authority to transfer, reassign, abolish, or consolidate the major combatant functions of the Services, thereby ensuring that the future role of the military departments would be limited to providing logistic support to the unified and specified commands.[3]

The Director, Defense Research and Engineering

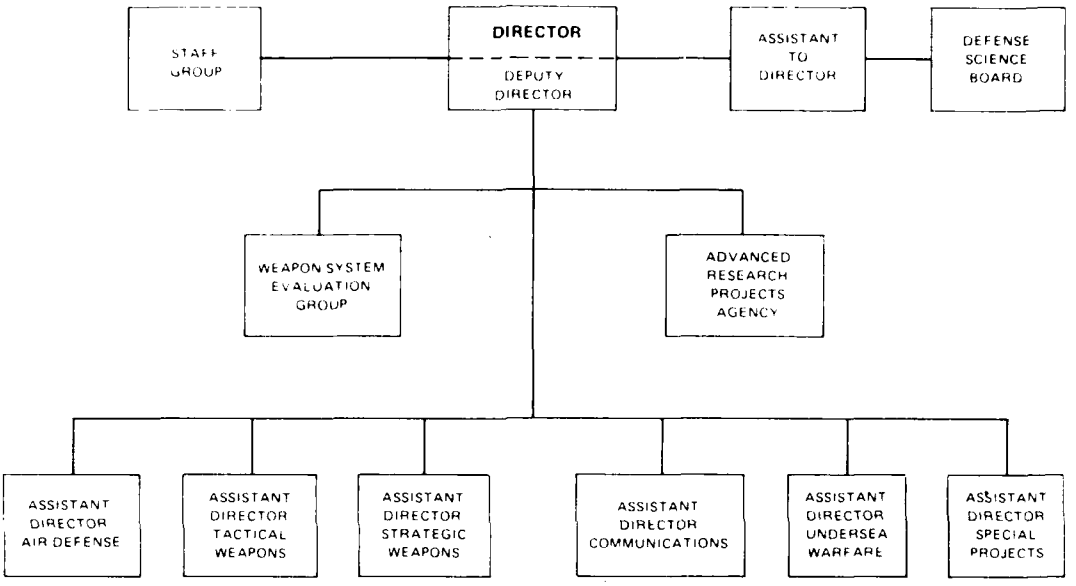
Research and development was an important factor in the move for reorganization, and it figured significantly in the eventual legislation. In amending the Declaration of Policy, the Reorganization Act noted that it was the intent of Congress to "eliminate unnecessary duplication in the Department of Defense, and particularly in the field of research and engineering by vesting its overall direction and control in the Secretary of Defense." To assist the Secretary in exercising his R&D authority, the Act upgraded the Assistant Secretary of Defense for Research and Engineering to the level of Director. As the third ranking civilian in the Office of the Secretary of Defense (ranking below the Secretary and the Deputy Secretary), the Director of Defense Research and Engineering (DDR&E) was to supervise all research and engineering activities in the Department of Defense, direct and control research and engineering activities deemed by the Secretary of Defense to require centralized management, and act as principal advisor to the Secretary of Defense on scientific and technical matters.[4]

The appointment of DDR&E was a major milestone in the management of defense R&D. Henceforth, ultimate responsibility for R&D rested with that office. The fact that R&D was assigned to the level of a Director rather than an Assistant Secretary of Defense indicated the importance and degree of emphasis accorded to research and engineering by the Department of Defense. Among the powers delegated to DDR&E was the authority to approve, modify or disapprove programs and projects of the military departments and other DOD agencies.[5]

President Eisenhower nominated Dr. Herbert York to serve as the first Director of Defense Research and Engineering. Shortly after York assumed control, the specifics of the organization of the new office began to emerge (see Exhibit I-17). York divided R&D into six operational areas (air defense, tactical weapons, strategic weapons, communications, undersea warfare, and special projects) each to be headed by an assistant director. The assistant directors had responsibility for supervising all RDT&E activities in their

respective areas and also for recommending to Dr. York actions on weapons systems and projects and appropriate funding for them. Small staffs comprised of military and civilian scientific personnel aided the assistant directors in their duties.[6]

EXHIBIT I-17
Director of Defense Research and Engineering 1959



Beyond the immediate staff, the Office of DDR&E had responsibility for the Defense Science Board, the Weapons System Evaluation Group, and the Institute for Defense Analysis. The last named organization was a nonprofit corporation (later designated a federal contract research center) that provided technical advice and support to ARPA and WSEG. DDR&E also had cognizance for the Research and Engineering Policy Council. The Council, a holdover from the Office of ASD(R&E), considered policies and procedures in defense R&D and made recommendations to DDR&E. It consisted of the Deputy Director of Defense Research and Engineering, and the senior civilian and military R&D officials from the Army, Navy, and Air Force.

Initially, York viewed the function of his office to advise and coordinate all defense research and engineering. He considered the examination of operational requirements to be the responsibility of the individual Services with DDR&E raising questions only when more information was required or when a requirement could not be met through the current state of technology. As time passed, however, it was readily apparent that York's

first impression changed, as evidenced by an increasing number of decisions being made by his office. Thus the impetus for centralization of R&D authority in DDR&E, a trend that became quite evident in later administrations, was present almost from the very start. To quote one executive in the Office of DDR&E in 1960:

> "There is no thing that would make our job easier and no thing that we would rather do than to leave the entire research and development job to the services. This, in point of fact, is exactly what we try to do. But we feel that there are many areas in which the services have abdicated their responsibilities. It's a matter, as we see it, of finding the best way to do the job."[7]

ASSISTANT SECRETARY OF THE NAVY (RESEARCH AND DEVELOPMENT)

The sweeping changes that resulted from the 1958 Department of Defense Reorganization Act prompted the Navy to appoint a committee, chaired by Under Secretary W.B. Franke, to study the organization of the Department of the Navy. Specifically, the Franke Board was to:

- Recommend an organizational structure that would ensure maximum combat effectiveness
- Recommend such organizational changes that would be necessary to maintain clear-cut authority and responsibility, proper lines of communication, and clear accountability
- Provide the Navy with the most effective, efficient, and economical administration.[8]

The Board submitted its report to the Secretary of the Navy on January 31, 1959.

The question of an Assistant Secretary of the Navy for R&D had been raised on several occasions, but in each instance the Navy concluded that the R&D function should remain a collateral responsibility of the ASN(Air). The Reorganization Act of 1958, however, decisively altered the situation by introducing a new and considerably more powerful defense-wide R&D office. In addition, the Act stipulated that each of the Services reduce the number of assistant secretaries from four to three. Accordingly, the Franke Board recommended that the Assistant Secretaries for Manpower and Air be disestablished and that an Assistant Secretary for R&D by designated. The Secretary of the Navy responded to the proposal by establishing an Assistant Secretary for R&D on February 5, 1959.[9]

The new ASN(R&D) assumed responsibility for all matters relative to Navy RDT&E efforts. Included among his duties was general management of the RDT&E appropriation.[10] This authority was unique and made ASN(R&D) the first and only assistant secretary for research and development within the Department of Defense with management control of an appropriation. The decision to delegate this authority to ASN(R&D) stemmed from the belief that maximum influence and effectiveness in dealing with DDR&E required that he have centralized control over Navy R&D funds. Moreover, control of the appropriation provided the new Assistant Secretary an effective tool to exercise internal management control over the R&D program by coupling his overall responsibility with the administration of available funds.[11]

DEPUTY CHIEF OF NAVAL OPERATIONS (DEVELOPMENT)

The decision to designate a senior civilian executive for research and development in the Office of the Secretary was followed by an analogous move in the Office of the Chief of Naval Operations. The Franke Board noted that cognizance for R&D in OPNAV was the responsibility of ACNO(R&D), but that important R&D functions were also exercised by the Deputy Chiefs for Fleet Operations and Readiness and Air. The Board also found that the augmentation of personnel that was to be part of the establishment of the ACNO(R&D) was never carried out.

After examining the overall R&D process, the Franke Board concluded that it "must be directed and supervised by an official who has complete responsibility and adequate authority to act in the name of the Chief of Naval Operations." As a result, it recommended that an official with the stature of a Deputy Chief of Naval Operations be appointed to discharge the R&D function.[12]

In making its recommendation, the Board took into consideration the expansion of the R&D appropriation to include test and evaluation, which it reasoned would increase the scope, program control, and coordination required in the Office of the Chief of Naval Operations. It therefore proposed that the responsibility of CNO for research, development, test, and evaluation be assigned to a single DCNO and that the responsibilities assigned to other divisions of OPNAV be transferred to the new Deputy. In addition, it recommended that the Office of the Development Coordinator, together with other scientific personnel in the Office of Naval Research, be reassigned to the proposed Office of the Deputy Chief of Naval Operations (Development).[13]

The Franke Board recommendations were implemented on 28 April 1959. Vice Admiral J.T. Hayward was designated as the first Deputy Chief of Naval Operations (Development) and given authority to coordinate and integrate the Navy RDT&E program in order to guarantee a total effort continuously responsive to long-range objectives,

immediate requirements, fiscal limitations, and advanced technology. Specific RDT&E responsibilities included the following:

- *Planning, forecasting, and determining* Navy requirements for RDT&E equipment, material, personnel, and supporting services
- *Coordinating and integrating* the RDT&E program of the Navy and Marine Corps
- *Coordinating and directing* the efforts of the bureaus and offices to ensure availability and distribution of these requirements.[14]

In accordance with the Franke Board recommendations, the Guided Missile Division of DCNO(Air) and the Office of the Development Coordinator were transferred to the Deputy Chief (Development). There were, however, other personnel and RDT&E responsibilities that were not transferred so that R&D responsibilities in OPNAV were not consolidated as originally intended but divided among three Deputy Chiefs (Air, Fleet Operations and Readiness, and Development).

The organization of the Deputy Chief of Naval Operations (Development) underwent several modifications in its first year of existence but was eventually divided into 12 major elements (divisions, directorates, and major staff groups). As indicated in Exhibit I-18, there was an Office of Development Programs within which were separate line divisions for ASW, Strike Warfare, Anti-air Warfare, Support, Atomic Energy, and Astronautics. Each of these "line" divisions performed staff functions (planning and internal coordination) and line functions (project monitorship and military evaluation). The main reason for the line divisions was to subdivide the total RDT&E into more manageable areas so that a single officer could be delegated authority to oversee the execution of R&D projects falling within a specific area. In addition to the line divisions, the DCNO (Development) was supported by several groups including an Advanced Technology Group and a Development Analysis Group. The latter organization consisted of personnel transferred from the old Office of Development Coordinator and served as the chief scientific and technical advisors to the DCNO (Development).[15]

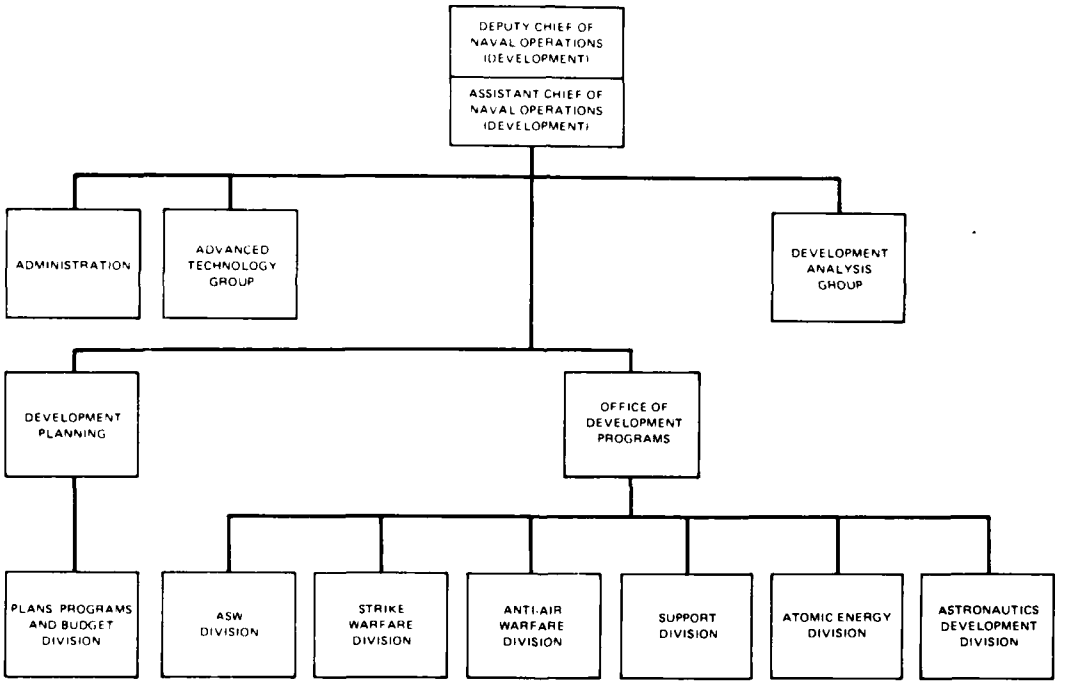
THE BUREAU OF NAVAL WEAPONS

The effectiveness of the material bureaus in developing weapons systems was another of the issues addressed by the Franke Board. The Board directed much of its attention to the cognizance dispute over guided missiles between the Bureaus of Ordnance and Aeronautics and concluded that advances in technology and weapons characteristics generally obscured the distinctions between the two bureaus. It also noted that

the Libby Board's solution of designating a lead bureau had serious limitations, since it failed to correct fundamental questions of cognizance and coordination.

After considering various alternatives, the Franke Board recommended merging the Bureaus of Ordnance and Aeronautics into a new Bureau of Naval Weapons. By consolidating the functions of the two contending bureaus, the Board believed that it would eliminate the cognizance dispute, expedite the development of all components of a weapons system, and place approximately two-thirds of the total development of the Navy under the direct authority and control of a single executive in the "producer" organization. Furthermore, the merger would eliminate the need for specially designated

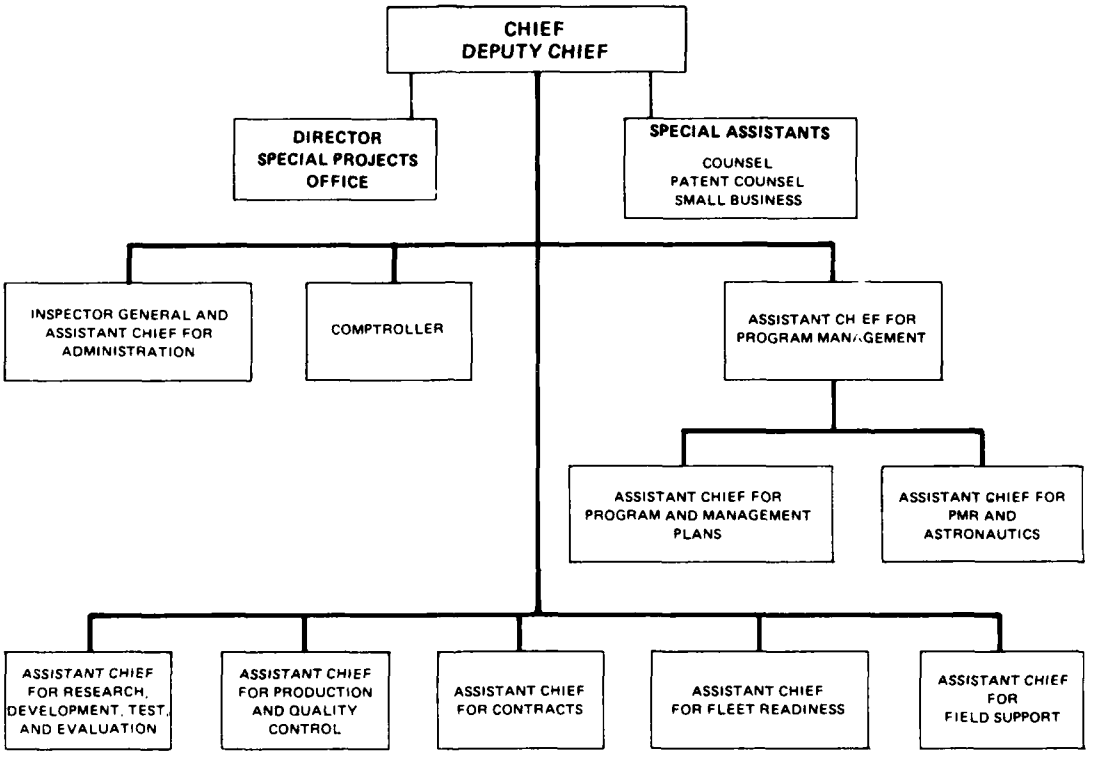
EXHIBIT I-18
Organization of the Deputy Chief of Naval Operations (Development) 1960



ad hoc organizations such as the Special Projects Office since there would be virtually no cognizance disputes.[16] The Bureau of Naval Weapons was created on 18 August 1959 but did not become fully operational until December. Its organizational structure is depicted

in Exhibit I-19 and the two elements in the organization especially relevant to R&D management are discussed in the following paragraphs.

EXHIBIT I-19
Bureau of Naval Weapons 1959



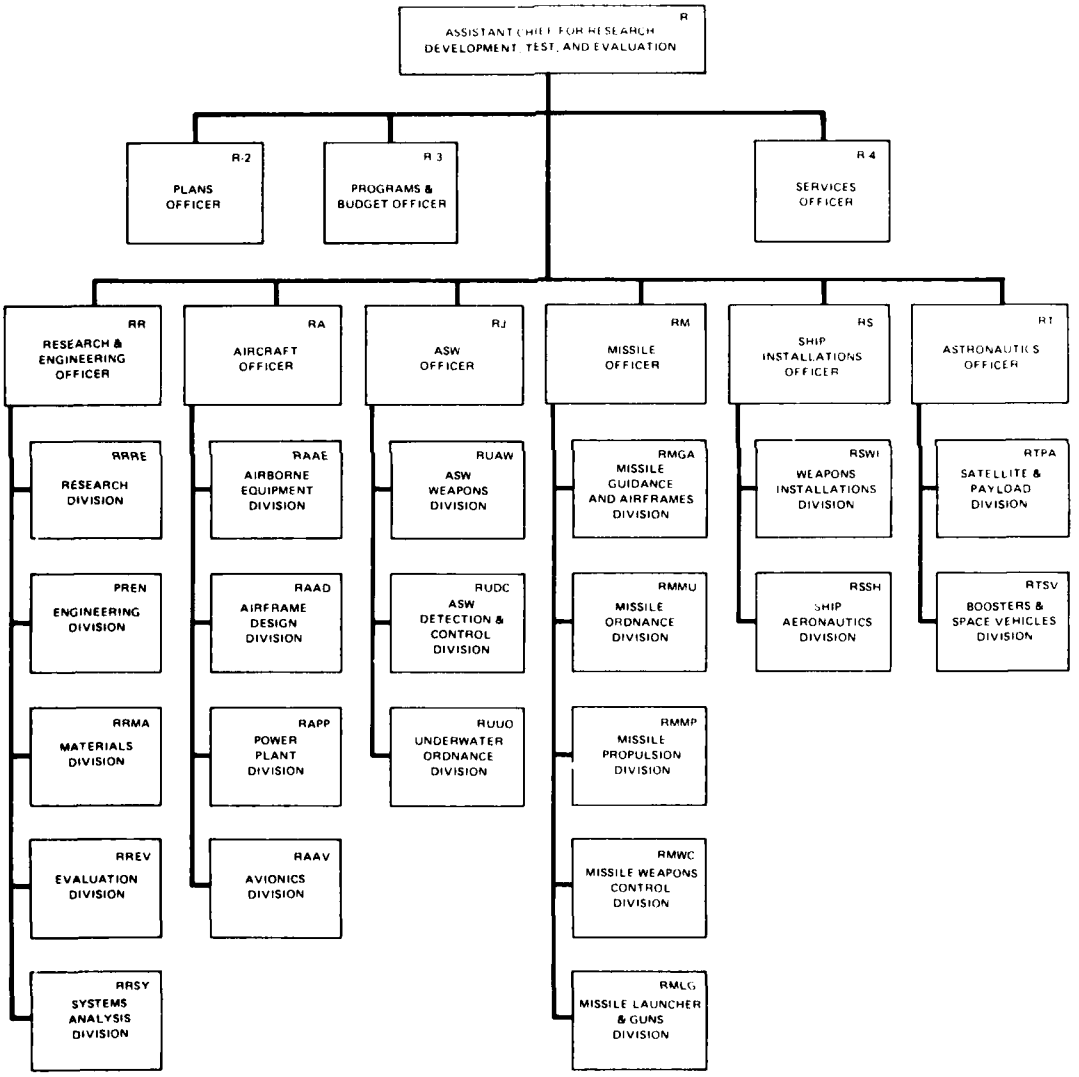
Assistant Chief for RDT&E

The Assistant Chief for RDT&E served as the senior R&D official in the Bureau of Naval Weapons. As head of the RDT&E Group, his responsibility extended to the conduct of basic, applied, and supporting research programs as well as to continuing engineering activities related to items in service use.

As depicted in Exhibit I-20, the RDT&E Group was organized to perform a number of tasks including long-range planning and management of weapons systems programs in

the research and development stages. Under the Assistant Chief were four offices with responsibility for systems development in the areas of aircraft, missiles, antisubmarine warfare, and astronautics. In addition to these subgroups, there were two principal advisors to the Assistant Chief. The Research and Engineering Officer was responsible for basic and applied research, general engineering, materials development, system analysis, and evaluation. The Ship Installation Officer was responsible for the final integration of developed aircraft weapons and assorted equipment into ships.[17]

EXHIBIT I-20
Office of the Assistant Chief for RDT&E, Bureau of Naval Weapons 1959



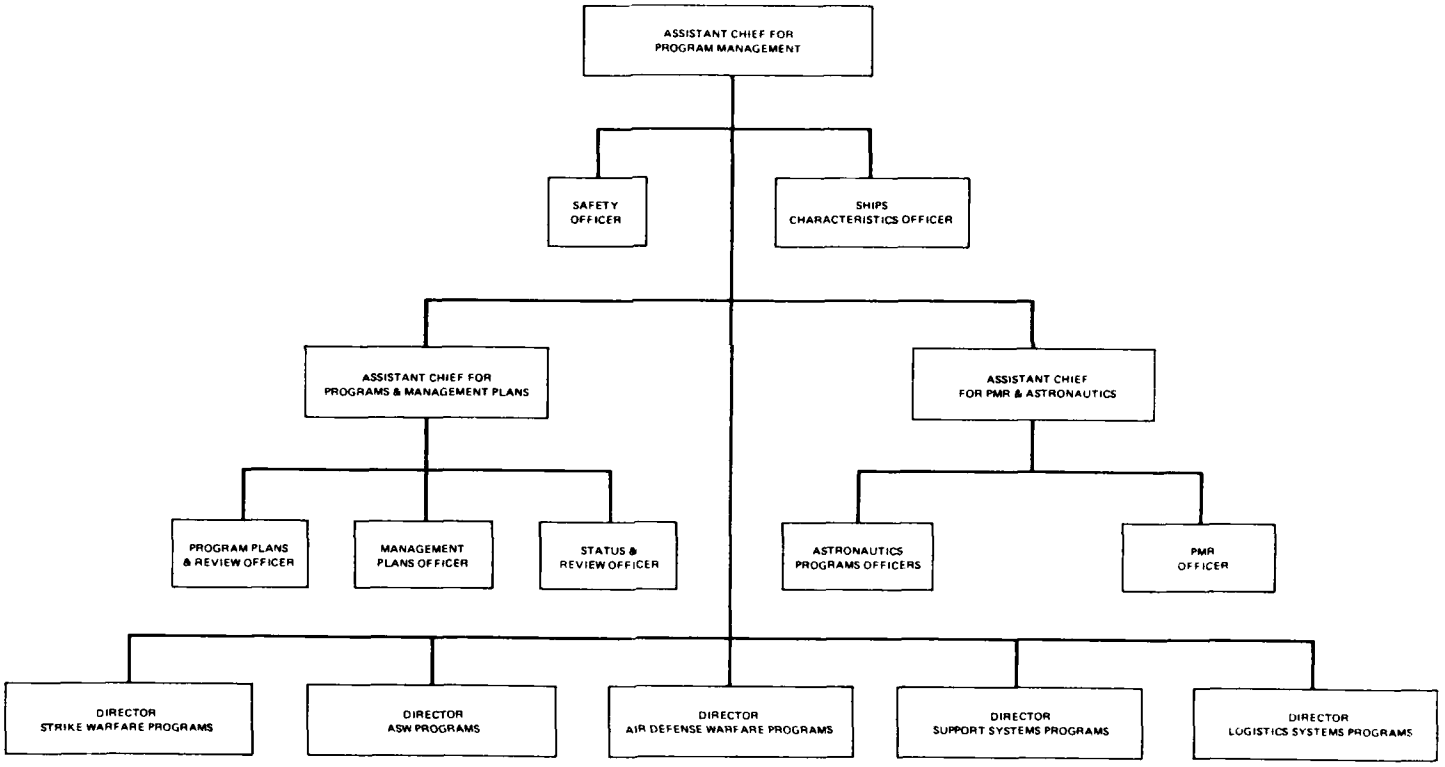
Assistant Chief (Program Management)

The establishment of an Assistant Chief (Program Management) represented a continuation of the trend started in the Bureaus of Ordnance and Aeronautics to give increased emphasis to project management. The Assistant Chief had responsibility for direction and management coordination of bureau-wide planning and also for most of the program management that the bureau performed, including all weapons systems in production.

The Program Management Group, as illustrated in Exhibit I-21, comprised two distinct organizations: directorates through which program management was executed and staff groups that provided planning policy and program management services for the entire bureau. The directorates were headed by program directors who had staff responsibility for coordinating functionally related groups. Each director was assisted by two or three assistant directors who were responsible for closely related functions within the scope of the directorate's responsibility. The Assistant Program Directors, in turn, were assigned subordinate staff who had responsibility for individual weapons system programs.

The staff elements of particular importance to program management were the Program Policy Review Division and the Plans Directorate. The former organization had three responsibilities: ensuring that policies, procedures, objectives, and systems established by the Plans and Program Group provided uniform direction and management coordination; providing independent progress and performance appraisal; and conducting special studies and projects on bureau material programs. The latter organization was responsible for directing and coordinating bureau-wide planning activities.[18]

EXHIBIT I-21
Office of the Assistant Chief for Program Management, Bureau of Naval Weapons 1959



Notes to Chapter 4

1. The Rockefeller Panel Reports, *Prospect for America* (New York, 1961), pp. 124-125.
2. Theodore W. Bauer and Harry B. Yoshpe, *Defense Organization and Management*, (Washington, D.C., 1971), p. 22.
3. P.L. 85-599.
4. Ibid.
5. DOD Instruction 5129.1, Subject: Director of Defense Research and Engineering, February 10, 1959.
6. "Research and Engineering," *Armed Forces Management*, VI, No. 2 (November 1959), 35-36.
7. "From Research to Hardware," *Armed Forces Management*, VII, No. 2 (November 1960), 92.
8. Department of the Navy, *Report of the Committee on Organization of the Department of the Navy* (Washington, D.C., 1959), pp. 19-20 (Hereinafter cited as the *Franke Board*).
9. Ibid., pp. 36-37.
10. SECNAV Instruction 5430.7C, Subject: Assignment of Responsibilities and Duties to the Under Secretary of the Navy, the Assistant Secretaries, and the Administrative Assistant, August 12, 1959; Personal Interviews.
11. Persona ...terview.
12. *Franke Board*, pp. 56-62.
13. Ibid.
14. OPNAVNOTE 5430, Subject: DCNO (Development) Charter; Promulgation of, January 9, 1960.
15. Department of the Navy, Navy Management Office, *Study of the Office of DCNO (Development) and the Navy RDT&E Program* (Washington, D.C., 1961), pp. 53-55, 66-67.
16. *Franke Board*, pp. 100-105.
17. "The Bureau of Naval Weapons," *Navy Management Review*, IV, No. 10 (October 1959), 11-13; Bureau of Naval Weapons, *Weapon System Program Managers Manual* (Washington, D.C., October 22, 1963), p. 12.
18. "The Bureau of Naval Weapons," *Navy Management Review*, pp. 8-10; Bureau of Naval Weapons, *Weapon Systems Program Managers Manual*, pp. 8-9.

CHAPTER 5

OFFICE OF THE SECRETARY OF DEFENSE 1960-1973

The Reorganization Act of 1958 represented the last major DOD-wide organizational shift during the era, but the pace of change showed no signs of abating. This was particularly true during the administration of Secretary of Defense Robert McNamara. Under Secretary McNamara, the potential authority provided by the 1958 Reorganization Act was fully realized. His administration was characterized by an aggressive management philosophy that tended to centralize authority in the Office of the Secretary of Defense (OSD). In the case of R&D, DDR&E became a paramount influence in defense decisionmaking.

The approach to defense management at the OSD level began to change somewhat in 1969 with the advent of the Laird-Packard administration. Defense Secretary Melvin Laird sought to reverse the centralizing trend and return a measure of authority to the military departments. In the Office of DDR&E this resulted in a change in personnel and a redirection of effort away from broad functional programs and toward concentration on specific mission areas. There were signs, however, which indicated that centralization was continuing, despite all efforts to the contrary. The establishment of a defense-wide test and evaluation function in the Office of DDR&E was evidence of the seemingly ineluctable trend.

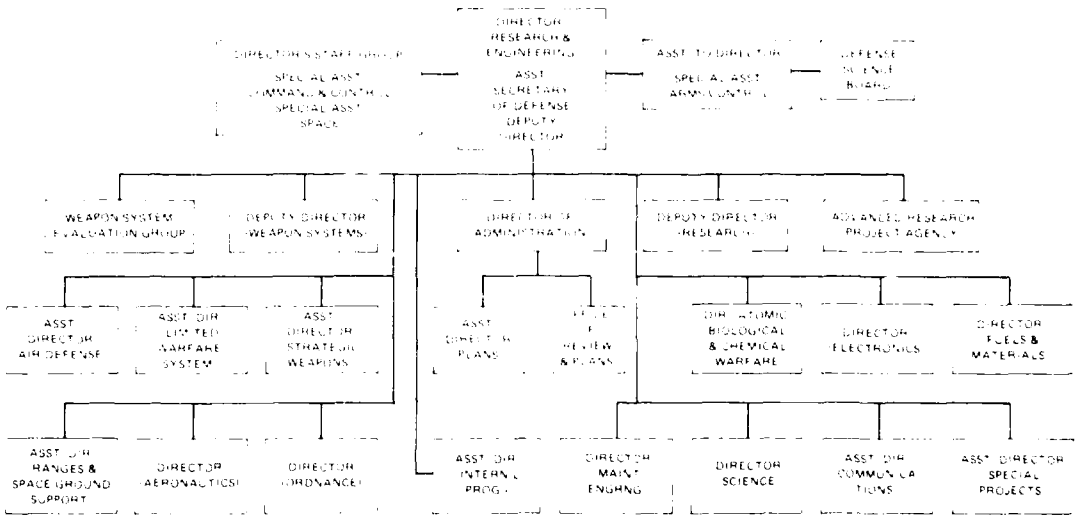
THE MCNAMARA ADMINISTRATION 1961-1968

In January 1961 Robert S. McNamara became the eighth Secretary of Defense. Shortly after taking office, McNamara ordered over 100 special study projects in an attempt to provide solutions and alternatives to fundamental defense problems. The studies became characteristic of the active management posture assumed by McNamara and his staff. Under McNamara's leadership, centralized direction of much of the Defense Department became a reality; defense-wide agencies were established for supply, intelligence, and contract audit. Perhaps most illustrative of the change initiated by McNamara was an increased reliance on management systems and procedures to effect centralized control. The Planning, Programming, and Budgeting System (PPBS), the six-part program structure, and concept formulation/contract definition are but a few examples of this trend which is discussed in further detail in Parts III and V.

Director of Defense Research and Engineering

The advent of the McNamara administration brought a new director to the Office of Defense Research and Engineering. The new incumbent, Dr. Harold Brown, made a number of adjustments in the organization of the 2-year-old office. Foremost among these was the appointment of deputy directors for weapons systems and research (see Exhibit I-22). Reporting to the Deputy Director for Weapon Systems were directors and assistant directors with authority to evaluate development programs in the technological areas of air defense, limited warfare systems, strategic weapons, range and ground support equipment, aeronautics and ordnance. The Deputy Director for Research was assigned responsibility for evaluating the applied and basic research effort; research was divided into separate offices for atomic, biological, and chemical warfare; electronics, fuels, and materials; maintenance engineering; science; communications; and special projects.[1]

EXHIBIT I-22
Office of the Director of Defense Research and Engineering 1961

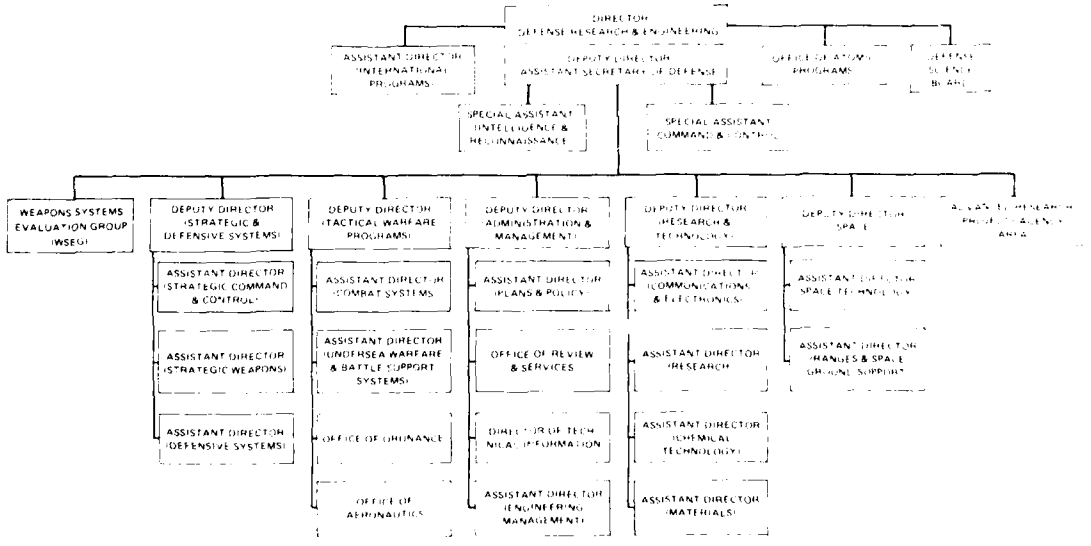


Under the guidance of Dr. Brown, the Office of the Director of Defense Research and Engineering devoted much of its energy to careful examination of major strategic and high-cost R&D programs. It was, however, clearly understood that DDR&E's activity extended to all R&D programs, and that any individual project was liable to close examination. Beyond the power of review, the DDR&E made full use of the controls available to him. These included the authority to initiate Advanced Research Projects Agency programs, transfer of R&D programs from one Service to another, and use the Emergency Fund (a pool of dollars allocated to the Secretary of Defense to provide some measure of

flexibility to defray costs arising from prompt exploitation of new developments and to meet unforeseen contingencies in specified RDT&E programs). The use of these tools enabled the DDR&E to directly control 7 percent of the Department of Defense RDT&E budget.[2]

In late 1962, the Office of DDR&E was reorganized to accommodate certain functional areas. The number of deputy directorates was extended from three to five, and the jurisdiction of each was significantly expanded. The five directorates now consisted of strategic systems, tactical warfare problems, research and information systems, engineering and chemistry, and administration. Shortly thereafter the research and information system directorate and engineering and chemistry directorate were merged into a single directorate for research and technology. Additionally, a space directorate was established (see Exhibit I-23). At the same time the DDR&E introduced new management and procedural tools which set the stage for much more detailed management of Service programs by the DDR&E and his staff.[3]

EXHIBIT I-23
Office of the Director of Defense
Research and Engineering 1964



The expanded role of DDR&E manifested itself in various ways. For example, the program review process became much more strenuous. In the words of one DDR&E spokesman at the time: "We cannot afford to support every research and development [illegible] which might be conceivable or even desirable. We must be increasingly discerning [illegible] to support."[4] As part of this effort to become more

"discerning" and make the best decision, DDR&E required the Services to furnish more and more program information. Another example of the expanded role was through increased use of program deferrals. These were used at key junctions in the planning, programming, and budgeting cycle to enforce program and technical judgements of the DDR&E staff. Deferrals were generally accompanied by demands for alterations in approach or additional information as a prerequisite for release of funds. A final example of the increased role of DDR&E was in the development of policies by the Directorate of Research and Technology governing the management of in-house laboratories.[5] This is discussed in more detail in Part II.

In 1965 Brown made further adjustments in the organization of the Office of DDR&E. The principal reason for the changes was the departure of two deputy directors and some organizational overlapping of responsibility. The primary changes involved the reorganization of the tactical warfare directorate, the merger of the strategic systems and space directorates, and the creation of a separate directorate for electronics and information systems. Following reorganization, Brown left to become Secretary of the Air Force. His replacement, Dr. John S. Foster, Jr., served through the remainder of the McNamara Administration. The principal organization change effected by Foster was the addition of a deputy directorate to deal specifically with Southeast Asian affairs. There were, however, important management and procedural initiatives undertaken under Dr. Foster, including introduction of the Development Concept Paper (DCP)[6] discussed in Part III.

Assistant Secretary of Defense for Systems Analysis

Another move in 1965 that had considerable significance for RDT&E was the designation of an Assistant Secretary of Defense for Systems Analysis [ASD(SA)]. Operating initially under the Defense Comptroller, the Systems Analysis Group had so grown in size and importance that it became the predominant management tool of the McNamara administration. Its elevation to the level of assistant secretary was indicative of its importance to the Secretary. Systems analysis, as defined by the first ASD(SA) Dr. Alain C. Enthoven, involved "the application of methods of quantitative economic analysis and scientific method in the broadest sense to the problems of choice of weapons systems and strategy." The Office of ASD(SA) worked closely with that of the Office of DDR&E; it frequently provided cost effectiveness estimates on development projects and also gave support to the systems analysis groups located in several of the deputy directorates. The military departments agreed, in theory, with the efficacy of developing quantitative measures for program alternatives but also demonstrated considerable skepticism as to many of the assumptions made by the so-called "paper studies."[7]

THE LAIRD-PACKARD ADMINISTRATION 1969-1973

In January 1969, President-elect Richard M. Nixon designated Melvin R. Laird Secretary of Defense. Laird's appointment as Secretary signalled the inauguration of a new management approach to defense decisionmaking. Laird contended that management had become excessively concentrated in the Office of the Secretary of Defense and that a major objective of his administration would be to decentralize authority as far as it was consistent with efficiency. Laird did not suggest that the defense management structure itself was basically at fault but rather that the management system was not as effective as it might be. As if to point this out, Laird appointed David Packard as his Deputy Secretary and encouraged him to take active leadership in defense management. A dual executive relationship emerged with Secretary Laird concentrating on policy matters and Deputy Secretary Packard focusing on daily operations.[8]

An important initiative taken early in the Laird-Packard administration was the refinement of principal decision milestones for major projects. Milestone management, the practice of designating specific check points to measure progress versus time and cost, was a familiar tool to the working-level R&D manager. Deputy Secretary Packard applied the procedure to the acquisition of major weapons systems through the creation of the Defense Systems Acquisition Review Council(DSARC). The Council was to meet at the critical milestones in the life of a major weapons systems project and make recommendations to the Secretary on whether or not to continue. It consisted of the DDR&E; the Assistant Secretaries of Defense for Installations and Logistics, Systems Analysis, and Comptroller; and the appropriate Service Secretary and his representatives.[9]

Director of Defense Research and Engineering

The Laird administration retained Dr. Foster as DDR&E, but the shift in management philosophy caused a considerable upheaval in the staff. Guidelines set down by Secretary Laird emphasized the replacement of centralized management with a "more participatory" approach. The Service Secretaries and the individual project managers were to be given more "action authority." The guidelines represented a significant shift and caused some dislocation. Those in DDR&E who persisted in the "old ways" (i.e., attempting to exercise authority over technical details) were subtly phased out and replaced with individuals more receptive to the new approach.[10] Dr. Foster articulated the new approach in this fashion:

> "You will shortly see a new definition and clarification of our lines of authority and responsibility for weapons system acquisition, within the Office of the Secretary of Defense, within the Services and in the relations between the two. . . .

> In the Office of the Secretary of Defense, for instance, you will see a shift toward added emphasis on future defense planning and away from the management of a given program. The senior civilians will require a detailed justification by the Services of a program, but once approved, the Services will run it. The Office of the Secretary of Defense will monitor the program but hold the Services responsible for the proper conduct of the approved program."[11]

Under the guidelines established by Secretary Laird and DDR&E Foster, a decentralization of decisionmaking did in fact occur. Service Secretaries and project managers were given more of a voice in the decisionmaking process and at the same time made more accountable for their decisions. Day-to-day program management was returned to the Services; the Services were also given a larger role in determining resource requirements and systems priorities and in reprogramming.[12]

Decisionmaking in DDR&E was divided into three areas. For major weapons systems, DDR&E was the responsible official for the development phase. He collaborated with the Service and other agencies to develop alternatives and options to present to the Secretary of Defense. After the Secretary made his decision, the program was assigned to one of the military departments with DDR&E functioning in a monitor/review capacity. In the case of intermediate systems, DDR&E made program decisions for the Secretary. The military department then assumed responsibility for final execution of the program. DDR&E worked directly with the military department in developing long-range program strategies for research and technology base projects which would then be implemented by the Services.[13]

Blue Ribbon Panel

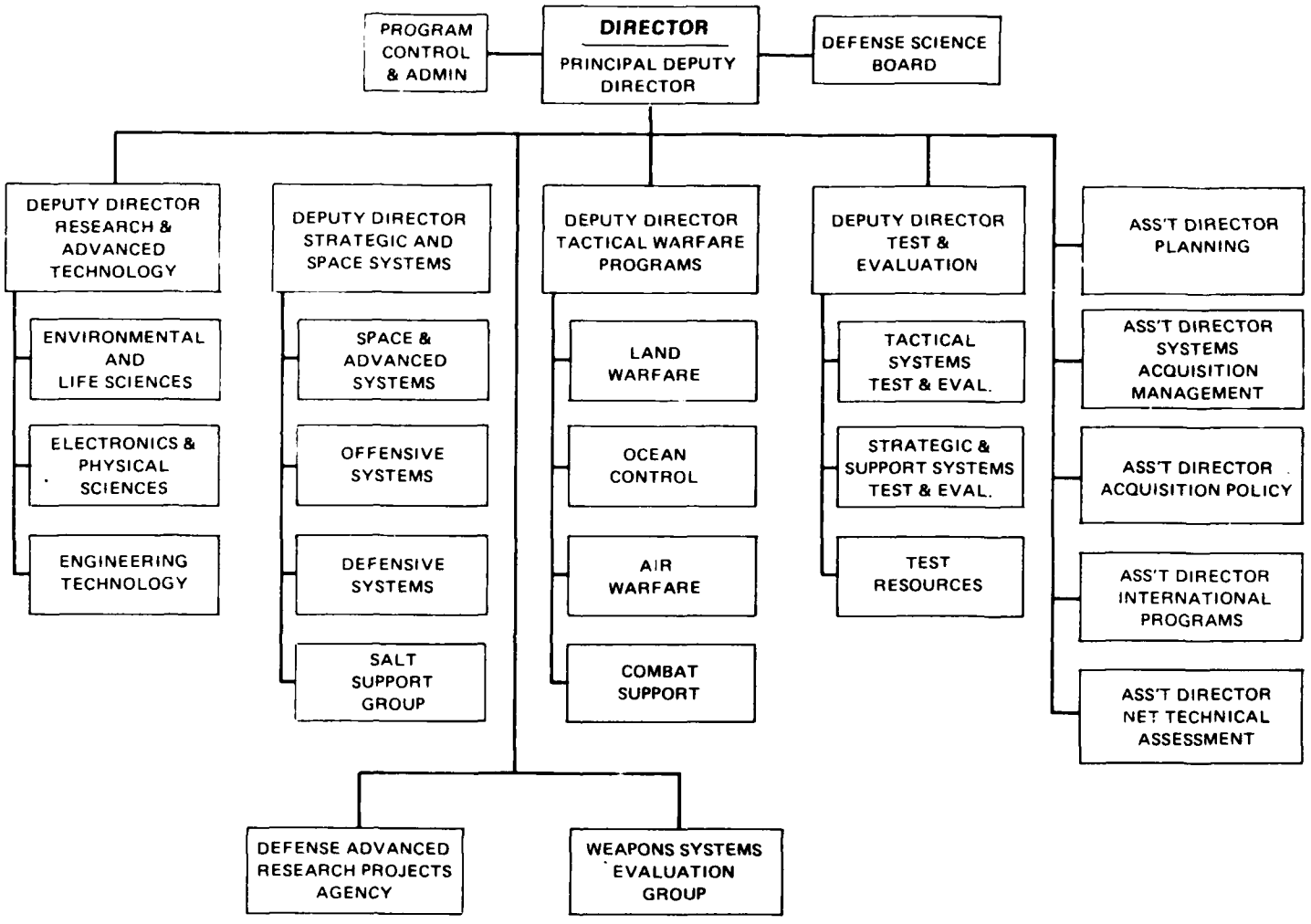
In July 1969, President Nixon and Secretary Laird appointed a "Blue Ribbon Defense Panel" to study the organization and management of the Department of Defense. Research and development figured prominently in the Panel's recommendations, submitted July 1, 1970. The most radical departure suggested was the abolition of the Office of DDR&E. In its place the Panel offered the proposal of splitting research and development between an Assistant Secretary for Research and Advanced Technology and an Assistant Secretary for Engineering Development. In addition, responsibility for research and exploratory development funds was to be delegated to the Advanced Research Projects Agency. The Panel was of the opinion that there was a fairly clear-cut distinction between research and advanced technology on the one hand and engineering development on the other, and that, as presently structured, the former had been neither sufficiently funded nor planned. It found that there was no adequate mechanism to protect funds appropriated for research and exploratory development from being diverted to the other

RDT&E categories and that the emphasis on mission justification only reinforced the diversionary tendency. Thus it was the desire to advance the so-called technological base that led the Panel to propose the division.[14]

While the proposal of splitting apart the functions of DDR&E was never implemented, the Panel's recommendation did have an impact in DDR&E. Dr. Foster's interest in technology base programs complemented that of the Blue Ribbon Panel. As a result of Foster's interest, certain advanced development programs were transferred from the systems directorate to the research and technology directorate. The Blue Ribbon Panel had also noted the absence of any DOD-wide test and evaluation agency and proposed that an Assistant Secretary of Defense for Test and Evaluation be established. Deputy Secretary Packard did not go so far as to designate an Assistant Secretary for Test and Evaluation, but a Deputy Director for Test and Evaluation was appointed in the Office of DDR&E. The Deputy Director for Test and Evaluation was given "across-the-board" responsibilities for test and evaluation in the Department of Defense. He was to monitor the test and evaluation programs conducted by the Services for DSARC-level programs and all other programs he considered to be vital. The rationale expressed by the Blue Ribbon Panel and concurred in by Deputy Secretary Packard was that a separate test and evaluation agency distinct from the military departments was needed to provide an independent assessment of operational developments. The DOD-wide agency would also provide test-related information to the Secretary who presumably would use it in making program decisions.[15]

The addition of the Deputy Director for Test and Evaluation in the Office of DDR&E represented the last major organizational change of the era. In mid-1973 Dr. Foster was succeeded as DDR&E by Dr. Malcolm R. Currie, who, like each of his predecessors, reorganized the office to reflect his own management philosophy. Currie's appointment represented a break with the past in that he was the first director selected with an industrial background. The changes Currie made in the DDR&E organization (see Exhibit I-24), more specifically the reduction in the number and size of the deputy directorates, suggested that future emphasis would be placed on improving management lines.

EXHIBIT I-24
Office of the Director of Defense Research and Engineering 1973



Notes to Chapter 5

1. "We do our job by Exception..." *Armed Forces Management*, VIII, No. 2 (November 1961), 83; National Science Foundation, *Federal Organization for Scientific Activities, 1962*; (Washington, D.C., 1962), pp. 115-116.

2. Department of the Navy, *Review of Management of the Department of the Navy; Research and Development Management Study*, Vol. II, Study 3, (Washington, D.C., October 19, 1962), NAVEXOS P-2426B-3, 24. (Hereinafter cited as *Dillon Board*).

3. Personal Interview; "New Controls Planned for R&D," *Armed Forces Management*, VIII, No. 10 (July 1962) pp. 29-31.

4. Donald Coble "Does DDR&E Overcontrol?" *Armed Forces Management*, XI, No. 1 (October 1964), 29.

5. *Dillon Board*, p. 27.

6. "A New Director Shares Some Old Problems." *Armed Forces Management*, XII, No. 2 (November 1965), 85-88.

7. Samuel A. Tucker (ed.), A Modern Design for Defense Decision: A McNamara-Hitch-Enthoven Anthology (Washington, D.C., 1966), p. 161; Craig Powell, "Have the Services Learned to Live With the Office of Systems Analysis?" *Armed Forces Management*, XII, No. 1 (October 1965), 73-76; Personal Interviews.

8. Bauer and Yoshpe, *Defense Organization and Management*, pp. 165-66, 168.

9. Deputy Secretary of Defense Memorandum, Subject: Establishment of the Defense System Acquisition Review Council, May 30, 1969.

10. Bauer and Yoshpe, *Defense Organization and Management*, pp. 190; Personal Interview.

11. "The New DOD Look-Decentralization," *Armed Forces Management*, XV, No. 12 (September 1969), 27.

12. Center for Strategic and International Studies, Georgetown University, *U.S. Military R&D Management*, (Washington, D.C., 1973), pp. 19-21.

13. "Defense R&D Is Having a Management Happening," *Armed Forces Management*, XVI, No. 1, (October 1969), 65-69.

14. Blue Ribbon Defense Panel, *Report to the President and the Secretary of the Defense on the Department of Defense*, (Washington, D.C., 1970), pp. 63-67.

15. Office of the Director of Defense Research and Engineering, Memorandum, Subject: Organization, Responsibilities and Functioning of the Office of Deputy Director (Test and Evaluation) DDR&E, August 24, 1971.

CHAPTER 6

THE NAVY DEPARTMENT 1960-1973

The centralization of R&D decisionmaking in the Office of the Director of Defense Research and Engineering profoundly influenced the roles and relationships of Navy headquarters R&D organizations. OSD demands for tighter control of individual projects and quick response to its information requirements placed substantial stress on the traditional bureau structure and led to a growing preoccupation among Navy Department officials with organizational solutions to management problems. Eventually, the Navy's system of virtually autonomous bureaus reporting directly to the Secretary was replaced by a Naval Material Command reporting to the Chief of Naval Operations. In addition, vertical organizations headed by program/project managers with authority to direct all organizational elements vital to their projects were superimposed over the traditional bureau structure. The steps through which these and other changes in headquarters R&D roles and relationships evolved during the period are described in the sections below.

ORGANIZATIONAL CHANGES 1960-1962

The years 1960-1962 represented a period of consolidation in which the changes instituted following the Franke Board were assimilated into the overall organization. The newly established offices of ASN(R&D) and DCNO(Dev), as well as the Bureau of Naval Weapons, formalized policies and procedures to fulfill their assigned responsibilities. While few organizational changes were introduced, some modifications were made in the Office of the Chief of Naval Operations, and one major project office was established. These events are discussed briefly in the following paragraphs.

Organizational Changes in OPNAV

It had long been the policy of the Navy to minimize the staff of its civilian executive assistants and to designate previously established offices to function as advisors. For example, when the Office of ASN(R&D) was established it was agreed that the Chief of Naval Research would serve as his principal advisor for research.

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In 1961, the Deputy Chief of Naval Operations (Development) was named a staff assistant to ASN(R&D) with responsibility for advising the ASN(R&D) on development programs and assisting him in assembly, integration, and coordination of the RDT&E program and budget. The assignment of the additional responsibility was based on DCNO(Dev)'s role as RDT&E appropriation sponsor in OPNAV, but the task required close coordination with the ONR Comptroller who served as staff to ASN(R&D) for financial management (see Chapter 14).[1]

Another noteworthy change in OPNAV involved the establishment of a Director of Antisubmarine Warfare (R&D). Antisubmarine warfare had been a concern of the Navy since World War I and was reflected in a number of organizational components in the Office of the Chief of Naval Operations and the bureaus. By 1958, ASW had so grown in importance that the CNO appointed an ASW Executive to provide for the planning and direction of the ASW program. Once established, however, the office was ignored and was disestablished 2 years later.[2]

In 1961, the Navy Management Office conducted a study on antisubmarine warfare research and development. As a result of the study, a flag officer was assigned as Director of Antisubmarine Warfare (Research and Development). He was directly responsible to the Assistant Secretary (R&D) for the direction and execution of the antisubmarine warfare R&D program and was also responsible to the Deputy Chief of Naval Operations (Development) for planning the program to fulfill antisubmarine warfare Operational Requirements.[3] The purpose of the "double hat" was to make the Director the focal point for all antisubmarine warfare research and development, requirements, planning, direction, and execution. In practice, the billet never lived up to expectations, since the real responsibility and authority for antisubmarine warfare R&D rested both with the staff of the Director of Defense Research and Engineering and with the Office of the DCNO (Fleet Operations and Readiness).[4]

Establishment of the Surface Missile Systems Project Office

Surface-to-air missile development in the Bureau of Ordnance dated back to the end of World War II. By the time of the formation of the Bureau of Naval Weapons, surface-to-air missiles were installed in several ships, and, by 1961, the number of ships equipped with missiles increased significantly. As more ships were equipped, however, it became apparent that there were serious technical and operational problems that remained unresolved. Certain steps were taken to remedy the problem, but the difficulties continued to mount.

In early 1962, an ASN(R&D) secret report stated that radical and sweeping changes in management, personnel policy, production, and technical approach were required to save the surface missile program from complete disaster. The principal recommendation

offered was to designate a competent program manager with the necessary support to overcome the existing limitations.

On January 26, 1962, BuWeps Chief RADM P.D. Stroop announced his decision to establish a special task force under the direction of an Assistant Chief for Surface Missile Systems (RADM E.T. Reich). Several weeks later, Secretary of the Navy Korth designated BuWeps the lead bureau for surface missile development. The task force created within BuWeps (known as the "G" group) consisted of a headquarters group attached to Assistant Chief Reich and working groups in each of the bureau's operating divisions.[5]

The scope of responsibility for surface missile systems changed considerably in July 1962 when Secretary Korth established a Navy Task Force for Surface Missile Systems. The Assistant Chief for Surface Missiles served as chairman of the task force and reported directly to Secretary Korth. The task force was responsible for all operations involving elements of those material bureaus engaged in surface missile work.[6]

As was the case with the creation of the Special Projects Office, the surface missile problem was considered by senior Navy officials to be a top priority item. In both cases the decision was made that extraordinary organizational measures were required to achieve the intensified program management believed necessary. Despite the fact that the Bureau of Naval Weapons served as the primary focus for the SMS project and that the special measures taken were not as disruptive as had been the case for the Special Projects Office, the mere establishment of another ad hoc organization once again raised questions of the efficacy of the current bureau organization.[7]

CREATION OF THE NAVAL MATERIAL SUPPORT ESTABLISHMENT

In the fall of 1961, the Secretary of the Navy and the Chief of Naval Operations began a series of discussions dealing with problems confronting Navy management. As a result of the discussions, the Secretary and the CNO agreed that a management study of the Department of the Navy be undertaken. Among the factors influencing the decision were:

- Awareness that the Navy had certain fundamental management problems
- A major reorganization of the Department of the Army
- Desire to avoid having such a study forced on the Department by the Secretary of Defense.

The study commenced in March 1962 under the direction of Administrative Assistant John Dillon.

The Dillon Board

The Dillon Board study concerned virtually all phases of management within the Department of the Navy; management of R&D was the subject of a separate volume. One of the paramount questions raised by the Board was: "Do we need change to provide the exceedingly quick response that the Secretary of Defense demands in reporting and decisionmaking?"[8]

In its assessment of Navy R&D management, the Dillon Board paid considerable attention to the question of reorganization. The Board found three principal problems with the existing Navy organization:

- Diffused responsibility among the RDT&E participants
- Absence of organizational flexibility to accommodate major system program management
- Pronounced imbalance between consumer (CNO) and producer (bureaus) in shaping the material effort.

To remedy these deficiencies, the Dillon Board considered a number of different alternatives. It examined the possibility of merging the Bureaus of Naval Weapons and Ships into a single material bureau. The logic advanced was that cognizance disputes would thus be eliminated, and that the producing organization could speak with a more authoritative voice. The Board rejected the proposal on the grounds that a much more drastic reorganization was required. It also considered the possibility of a Bureau of Research and Development whereby all RDT&E authority was consolidated in a single executive. This solution was eliminated on account of the lack of "cradle-to-grave" responsibility for any major system and the inevitable isolation that would result. Finally, the Board discussed the possibility of reorganization above the bureau level. Various alternatives were offered, and the Board concluded that a suprabureau organization was required.[9]

The solution the Dillon Board offered was the establishment of a Chief of Naval Support to coordinate, control, direct, and command the Chiefs of the Bureaus of Naval Weapons, Ships, Supplies and Accounts, and Yards and Docks. The Board maintained that a single producer executive was necessary to weigh and balance the competing demands for material resources by the bureaus and be responsible for the effective management of the Navy's material bureaus.

The imposition of a new structure between the bureaus and the Secretary of the Navy represented, of course, radical departure from the past. The Board reasoned that the

lead bureau system was a failure and that an office was needed to reconcile differences among the coequal bureau chiefs. The Chief of Naval Support could strengthen project management by virtue of his control and direction of the resources of the bureaus.[10]

An important element in the proposed Office of the Chief of Naval Support was the Deputy Chief of Naval Support for Development. The Deputy Chief (Development) would be the principal official for coordination and integration of the Navy's development, test, and evaluation programs. Again, there was a potential problem with excessive layering, in this case with the Deputy Chief of Naval Operations (Development). The Board suggested that only a sharp division of responsibilities between producer and user could eliminate such a possibility and recommended that once the Office of the Chief of Naval Support was established, an objective appraisal be made in the Office of the Chief of Naval Operations to determine which functions might be more appropriate in the producer organization.[11]

It needs to be recognized that the Dillon Board was not unanimous in its recommendation for the establishment of a Chief of Naval Support. Admiral Claude Ricketts, Vice Chief of Naval Operations, opposed the creation of a Chief of Naval Support on the grounds that it would add an administrative layer between the bureaus, the Secretary of the Navy, and the Chief of Naval Operations which would "complicate rather than simplify the practical procedures." Ricketts also believed that in order to function effectively as the single point of contact for the producer organization, the CNM would require staff and authority that would all but destroy the bureau system. The majority of the Dillon Board, however, thought this possibility could be diminished by a careful wording of the charter of the office.[12]

Chief of Naval Material

When considering the Dillon Board recommendations, Secretary of the Navy Fred Korth decided that rather than abolish the Office of Chief of Naval Material (CNM), he would use it as the basis for the proposed Chief of Naval Support. A new material billet would have required repeal of the legislation establishing the CNM, and Korth reasoned that the congressional process would be time consuming. The only problem with retaining the CNM was the fact that his responsibility did not include weapons systems development. There was also some concern that an amendment to the 1948 law establishing CNM would be necessary, but, upon examining the statutes governing the bureaus, the Secretary concluded that the bureaus had no specific duties other than those assigned by the Secretary. Thus, the Secretary of the Navy could require the bureaus to report to him through the Chief of Naval Material solely on the basis of administrative fiat.[13]

On May 28, 1963, Secretary Korth announced that in lieu of creating a Chief of Naval Support, the objectives of the Dillon Board could be accomplished by assigning the responsibilities to the CNM. At the same time, Vice Admiral W..A. Schoech was designated the new Chief of Naval Material and directed by the Secretary to initiate the planning for a "new" Office of Naval Material.[14]

It was Schoech's impression that the CNM would provide command and supervision of the four material bureaus, i.e., would control but not operate. The new CNM established the policy of having functions performed as far down in the organization as possible. Duties were not to be discharged at the CNM level when they could be accomplished more successfully by a bureau; this was particularly true in the case of providing technical services.[15]

General Order 5, of July 1, 1963, defined the new responsibilities of the Chief of Naval Material. He was to serve as the Naval Material Support Assistant to the Secretary and act as the head of the Naval Material Support Establishment (NMSE). His specific responsibilities included:

- Providing material support to the operating forces of the Navy and Marine Corps
- Planning for and developing the resource capabilities of the NMSE
- Planning for the utilization of resources in the performance of work to meet material support needs
- Providing the CNO and CMC with technical advice
- Providing for and applying project management within NMSE, including the establishment of designated projects reporting directly to the CNM or under project managers reporting to bureau chiefs.[16]

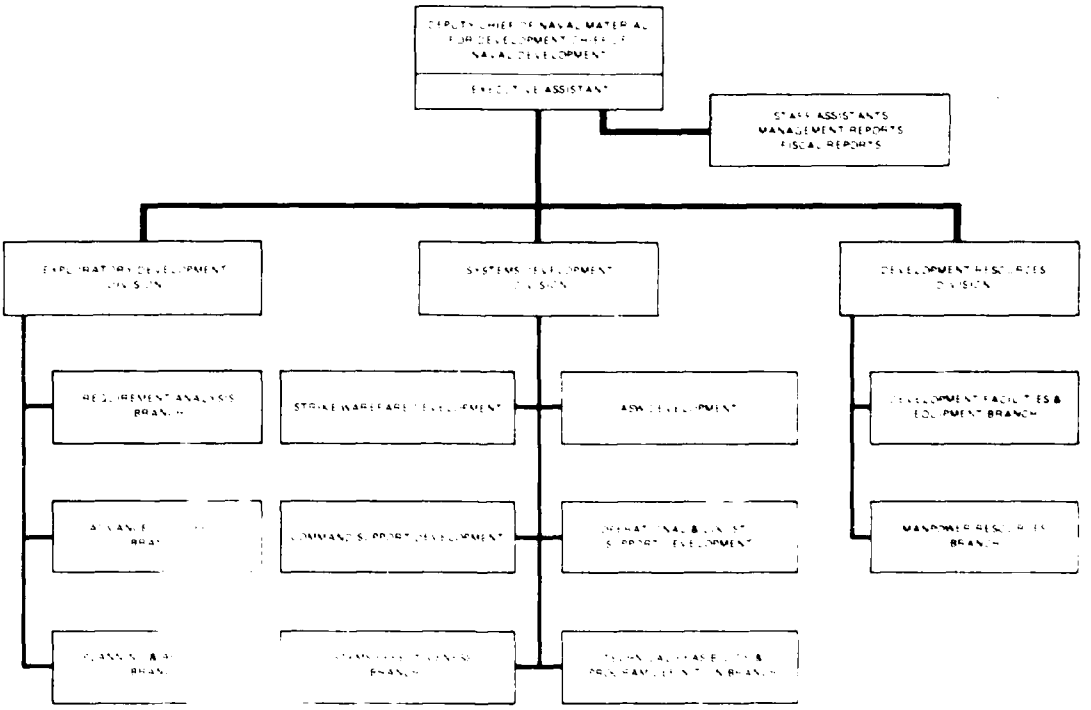
The organization of the Office of Naval Material included four Deputy Chiefs: Financial Management, Development, Material and Qualities, and Management and Organization. The Deputy Chiefs were to assist the CNM in his coordination of the work of the bureaus. In some instances there were operating responsibilities assigned to the deputies, but only where the CNM concluded that such responsibility could result in more effective management.

Deputy Chief of Naval Material (Development)

Following the recommendation of the Dillon Board, one of the Deputy Chiefs established had primary responsibility for coordination and direction of development, test, and evaluation programs. In carrying out this general function, the Deputy Chief of Naval Material (Development) was to translate Operational Requirements into technical plans, direct the preparation of detailed execution plans for DT&E projects, manage the implementation of DT&E programs, and appraise said programs in terms of performance achieved versus funds, time, and effort expended.[17]

As illustrated in Exhibit I-25 the organization of the DCNM(Dev) divided primary responsibility for management and coordination of development, test, and evaluation programs between the Exploratory Development and Systems Development Divisions. A third organization, the Development Resources Division, had responsibility for the optimal utilization and management coordination of all development resources available to the NMSE in supporting the DT&E program.[18]

EXHIBIT I-25
Deputy Chief of Naval Material (Development) 1964



Designated Project Managers in the Naval Material Support Establishment

The Dillon Board emphasized the importance of project management and recommended that use of designated centralized management authority be expanded in the proposed support organization. Within the NMSE, project management techniques were applied to high priority projects designated by the Secretary of the Navy, the Chief of Naval Material, and the chiefs of the material bureaus.

In its first full year in operation, the primary contribution made by NMSE to project management was the codification of management procedures used within the Navy for project management. Charters were written for three SECNAV-designated projects (Fleet Ballistic Missile, Surface Missile Systems, and Antisubmarine Warfare), and three CNM-designated projects (F-111B/Phoenix, Instrumentation Ships Project, and All-Weather Carrier Landing System).[19]

A Directive issued in May 1965 by Deputy Secretary of Defense Cyrus Vance prescribed the policy for the use of project management in the Department of Defense. It established mandatory application of program management efforts rated in the high priority category and those estimated in excess of $25 million in RDT&E financing or in excess of $100 million in total production investment. Additionally, it defined the role of the program manager to include responsibility for the planning, direction, and control of the project and over the allocation and utilization of all resources authorized for it.[20]

Secretary of the Navy Paul Nitze announced in September 1965 that it was the policy of the Navy to encourage and support the use of project management and ordered the CNM to develop an overall concept for the establishment of designated projects within NMSE. The CNM instruction, issued in December, defined the procedures involved in the establishment and disestablishment of projects and enumerated the authority and responsiblities of the project manager. It also stated that the project managers should use to the fullest extent possible the functional elements of the bureaus to perform project tasks. By the end of 1965 there was a total of 28 designated projects within the Navy (10 reporting directly to the CNM and 18 reporting to the Chiefs of the Bureaus of Ships and Naval Weapons).[21]

ADJUSTMENTS IN ASN(R&D)'S ORGANIZATIONAL RELATIONSHIPS

The Dillon Board noted that the responsibilities for RDT&E management were "confusingly divided" among ASN(R&D), OPNAV, and the bureaus. Both responsibility and accountability were ambiguous. Indicative of the situation was the growing role of OPNAV in program planning and direction. The principal solution offered by the Board was the creation of the Chief of Naval Support, but it also recommended that the ASN(R&D) take steps to strengthen his policy role in certain areas of the RDT&E effort.

Creation of the Chief of Naval Development

Among the problem areas investigated by the Dillon Board was the management of Exploratory Development. The Board noted that funds appropriated for Exploratory Development were frequently diverted to use in system developments. The application of Exploratory Development money to take care of reprogramming actions in system development resulted in both a lack of stability in the Exploratory Development Program and a lack of flexibility to pursue new and promising ideas.[22] In its final report, the Dillon Board concluded that there was a real danger of becoming shortsighted in the RDT&E process and that it was necessary to "build a fence" around Exploratory Development. To achieve this objective, the study recommended that the ASN(R&D) develop policies and procedures to clearly establish the position of Exploratory Development and to ensure its adequate support. It also advised that an organizational unit labeled Exploratory Development be established in the proposed Chief of Naval Support Organization.[23]

Implementation of the Dillon Board proposals began in early 1963. The ASN(R&D) established a committee (Group B) to consider actions in response to the Exploratory Development recommendations. The Assistant Secretary stated that he regarded the management of Exploratory Development, including its coupling with Research and Advanced Development, to be unsatisfactory and that he wanted someone to control the program, responsible to him for coordination. Group B considered the establishment of a Chief of Naval Development as a separate position in the Office of the Assistant Secretary for R&D but concluded that a "double hat" arrangement with the DCNM(Dev) was preferable. The Deputy Chief of Naval Material for Development had recently been assigned responsibility for coordinating the Exploratory Development Program in the Naval Material Support Establishment. As Chief of Naval Development, he would have the additional coordinating authority over the other participants in the Exploratory Development Program (Office of Naval Research, Bureau of Medicine, Bureau of Personnel, and the Marine Corps).[24]

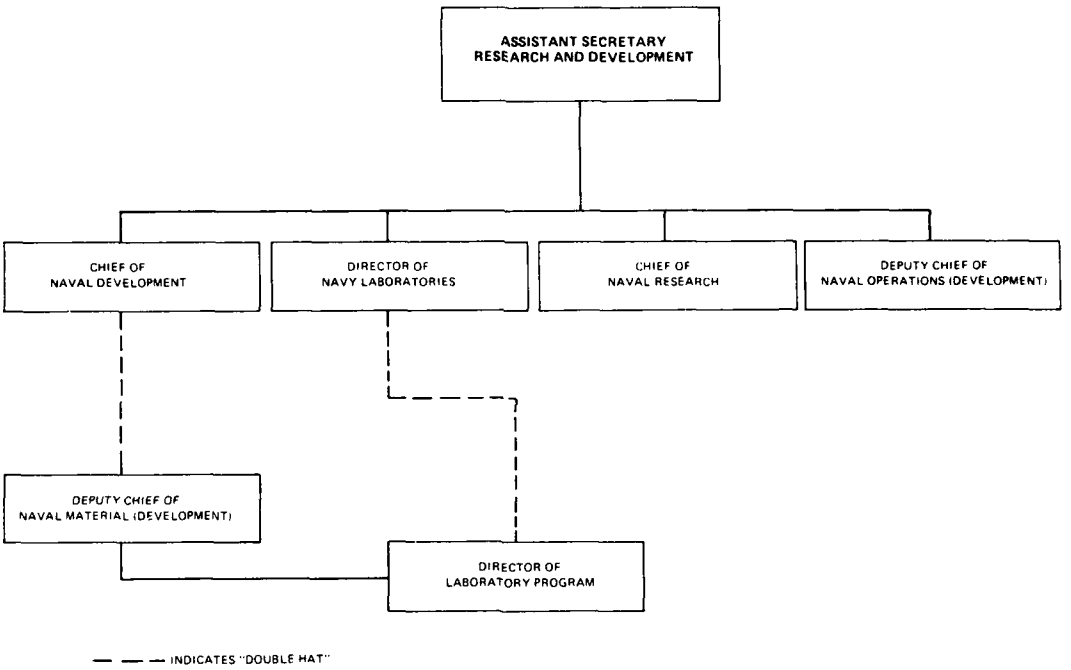
The Office of the Chief of Naval Development was formally established in June 1964. Its primary function was to coordinate the Navy's Exploratory Development Program for the Assistant Secretary for R&D. In this role, the function of the Chief of Naval Development paralleled that of the Chief of Naval Research for the Naval Research Program.[25] Notably missing from the Chief of Naval Development's charter, however, was authority for establishing firm procedural controls over the transition from Exploratory Development to Advanced Development.

Establishment of the Director of Naval Laboratories/Director of Laboratory Programs

The final extension of the staff of ASN(R&D) involved the establishment of a Director of Naval Laboratories. The position had its origin as a result of a plan developed

by the Office of the Secretary of Defense. In 1964 the Deputy Director of Defense Research and Engineering (Research and Technology), Chalmers Sherwin, presented a proposal designed to improve the quality of the defense laboratories. As it applied to the Navy, the Sherwin Plan proposed to separate the laboratories from the bureaus and place them under the independent administration of a civilian laboratory director who would serve as staff to the Assistant Secretary (R&D) (see Chapter 8).[26]

EXHIBIT I-26
Assistant Secretary of the Navy
(Research and Development) 1966



The Sherwin Plan met with little enthusiasm within the Navy, and the ASN(R&D) organized a committee to prepare an appropriate response. The committee agreed that the laboratories required special management attention, but that isolating them from the rest of the Navy would only jeopardize the overall RDT&E effort. Consequently, the approach they recommended significantly modified the Sherwin Plan. The committee endorsed the idea that the Navy should establish a civilian Director of Naval Laboratories who would have coequal status on the staff of the ASN(R&D) with the Chiefs of Naval Research and Naval Development, but rejected the separation of the laboratories from the bureaus. It reasoned that the proposed director would provide the necessary department-wide attention to the optimal development and use of the Navy's laboratories without disrupting the traditional laboratory-bureau relationship.[27]

As eventually implemented, the ASN(R&D) utilized the "double hat" approach that he previously employed with the position of CND. The problem with the proposed Director of Naval Laboratories was that it was a staff position with no line authority. In an effort to give the incumbent a measure of authority and to make the billet more attractive, the ASN(R&D) proposed the creation of a second operating position in the Office of DCNM(Dev). The second post would be designated Director of Laboratory Programs and would be made responsible for general administration of the Navy laboratories through the CNM organization. The DNL/DLP billet was officially established in December 1965.[28]

CREATION OF THE NAVAL MATERIAL COMMAND 1966

The 1963 reorganization placed the four material bureaus under the Chief of Naval Material and established a single point of contact for all Navy logistics. There were, however, a host of issues that remained unresolved.

The Bureau of Naval Weapons represented a major problem to many senior officials. BuWeps controlled 60% of the assets of NMSE, and critics asserted that it was too large an organization to be effectively managed. Moreover, while the merger of Bureaus of Ordnance and Aeronautics simplified the aircraft-weapons interface, it further complicated the ships-weapons interface. There was also concern that the bureau management subordinated the non-air ordnance programs to the point that the ordnance capability was seriously lagging.[29]

Program management presented a different type of difficulty. The relationship of the program managers to the bureau chiefs was not always clear. In some cases project management offices were created and subsequently expanded to fill voids in the existing bureau organization. This led to an overexpansion of some program management offices which further diluted bureau skills and responsibilities and downgraded the role of the bureau organization.[30]

A third issue centered on the role of CNM. As Admiral Ricketts noted in his dissent, CNM would either be a clerical office for the consolidation and processing of papers, or it would gather a large technical staff which in effect would cause the bureaus to cease to function. The initial incumbent CNM kept the organization relatively small and served largely in a coordinating capacity. When the office changed hands, the perception of the role of CNM also changed. The new CNM envisaged a far more active role and, with the support of the Secretary of the Navy, took steps to remedy perceived deficiencies.[31]

Shortly after taking command as Chief of Naval Material, Admiral I. J. Galantin ordered a reorganization study team to analyze various approaches to material organizations. It was Galantin's impression that the concentration of NMSE resources and

technical responsibility in the Bureaus of Ships and Naval Weapons made effective management of technology difficult to accomplish. Thus it was Galantin's objective to reduce the technical scope of the bureaus into more manageable concentrations.[32] Additionally, because of the growing competition for funds and personnel, it would be necessary to give CNM command authority over the bureau chiefs rather than simply review and coordination authority.

Several months after the study was launched, Admiral Galantin convened a meeting of the chiefs of the material bureaus together with representatives of the Chief of Naval Operations and the Secretary of the Navy. Out of that conference came agreement that a reorganization of the material bureaus was in order. The conference agreed that the name of the Naval Material Support Establishment be changed to the Naval Material Command and that the four material bureaus be reorganized into six functional commands.[33]

The primary change proposed by the reorganization was the recognition of a separate status for the ordnance and electronics technologies. As mentioned previously, there was concern that the merger of ordnance and aeronautics had blurred the ordnance function. Hence, the proposed division of the Bureau of Naval Weapons into aeronautics and ordnance commands. In the case of electronics, the argument was that BuShips was oriented toward naval architecture and that the electronics technology required a separate organization. Accordingly, the initial plan was to concentrate all electronics in one organization. Opponents of the scheme argued that electronics was a tool of many purposes and firmly embedded in a number of organizations. A compromise emerged whereby the electronics organization would be separated from the Bureau of Ships and given responsibility for electronics policies and hardware which extended beyond the purview of either aeronautics or ships (e.g., shore communications and Navy-wide navigation systems).[34]

On March 7, 1966, Secretary Nitze reported that the proposals for reorganization of the Navy had been approved by Defense Secretary McNamara. The principal elements of the reorganization plan were:

- Restructuring the bilinear system into a unilinear organization by placing the material, medical, and personnel functions under the command of the Chief of Naval Operations
- Reconstituting the Naval Material Support Establishment as the Naval Material Command
- Restructuring the four material bureaus into six functional commands.

The purpose of the reorganization, according to Secretary Nitze, was "to enable the Navy to more effectively carry out its functions of preparing naval forces for assignment to unified and specified commanders and developing and providing the manpower and material resources to support naval forces."[35] The particular organizational elements of the Naval Material Command are discussed in the following sections.

Headquarters, Naval Material Command

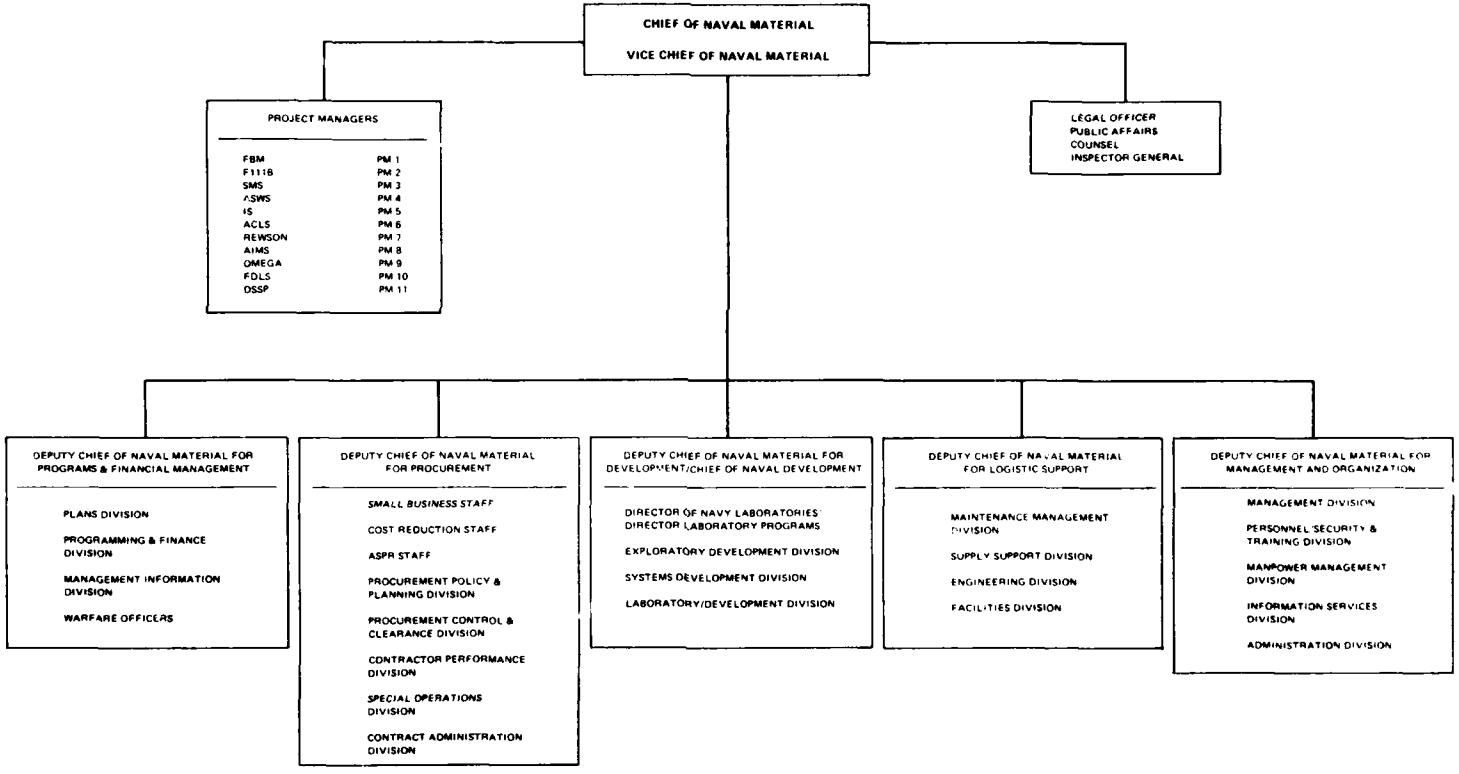
The Naval Material Command (NMC) was designed to function as a decentralized organization similar to a large industrial corporation. The headquarters organizations would serve as the corporate level; the systems commands would correspond to the several operating divisions; and the designated project managers would correspond to special-purpose operating elements.

The headquarters organization that developed in the Naval Material Support Establishment remained in place under the Naval Material Command (see Exhibit I-27). Because of the change in reporting relationships, there was serious consideration given to the problem of duplication between NMC and the Office of the Chief of Naval Operations. Studies were made and areas of duplication identified, most notably in RDT&E, logistics, and communications. The effort to streamline organization and reassign functions to the NMC met with considerable reluctance in OPNAV; without the support and commitment of senior management the tendency was to carry on "business as usual" and the end result was a duplication of effort that continued through the remainder of the era.[36]

The Systems Commands

In transforming the bureaus into systems commands, the basic problem was determining the cognizance of the individual organization (see Exhibit I-28). Once that was resolved, the question then became one of the internal structure. There were, however, certain stipulations laid down by the Chief of Naval Material concerning the basic organizational structure of each of the material groups. An attempt was made to produce a standardized organizational design that paralleled that of the Naval Material Command Headquarters. Each of the systems commands was to have a separate organization for Finance(Code 01), Contracts(Code 02), and Research and Technology(Code 03); the remainder of the organization would be permitted to vary with the product line. An important consequence of the standardized approach was the division of RDT&E responsibilities among several organizations. The research and technology group was to manage work performed in the categories of Research, Exploratory Development, and certain Advanced Development projects. A second organization would assume

EXHIBIT I-27
Headquarters, Naval Material Command 1966



responsibility for systems development. The stated purpose for the division was to stress the importance of the technology base in material development and prevent Research and Exploratory Development funds from being diverted to achieve solutions to problems in acquisition projects.

EXHIBIT I-28
Systems Commands of the Naval Material Command

SYSTEMS COMMANDS OF THE NAVAL MATERIAL COMMAND					
MAJOR PROGRAMS AND FUNCTIONS					
NAVAL SHIP SYSTEMS COMMAND	NAVAL AIR SYSTEMS COMMAND	NAVAL ORDNANCE SYSTEMS COMMAND	NAVAL ELECTRONIC SYSTEMS COMMAND	NAVAL FACILITIES ENGINEERING COMMAND	NAVAL SUPPLY SYSTEMS COMMAND
• SHIPS AND CRAFT ACQUISITION, CONVERSION, MODERNIZATION, OVERHAUL • SHIP SYSTEM INTEGRATION AND LIFE CYCLE MANAGEMENT • SHIP EQUIPMENT (HULL, MACHINERY, ELECTRICAL, OTHERS • SALVAGE AND DIVING • SONARS AND SURVEILLANCE RADARS • INACTIVE (RESERVE FLEET) SHIP MANAGEMENT	• AIRCRAFT ACQUISITION, MODERNIZATION, OVERHAUL • AIRCRAFT EQUIPMENT • AIRCRAFT SYSTEM INTEGRATION • AIR LAUNCHED WEAPONS AND EXPENDABLES • SHIPBOARD CATAPULTS, ARRESTING GEAR, VISUAL LANDING AIDS • PHOTOGRAPHIC EQUIPMENT AND TECHNOLOGY • METEOROLOGIC EQUIPMENT AND TECHNOLOGY	• SHIPBOARD WEAPON SYSTEMS ACQUISITION, MODERNIZATION, OVERHAUL • ORDNANCE SYSTEM INTEGRATION • MINES, TORPEDOES, GUN AMMUNITION, SHIP LAUNCHED MISSILES ACQUISITION, STORAGE, LOADING, ASSEMBLY, ETC • EXPLOSIVES TECHNOLOGY, SAFETY, DISPOSAL • SMALL ARMS, SWIMMER WEAPONS, DEMOLITION CHARGES, ETC	• COMMUNICATIONS SYSTEMS, SHIP, SHORE, SATELLITE • FIXED SURVEILLANCE SYSTEMS • NAVIGATION AIDS, AIR TRAFFIC CONTROL EQUIPMENT • COMMAND CONTROL SYSTEMS • GENERAL TEST AND TELEMETRY EQUIPMENT • ELECTRONIC WARFARE EQUIPMENT, SHIP, SHORE • ELECTRONIC TECHNOLOGY, COMPATABILITY, ETC	• MILITARY CONSTRUCTION • REAL PROPERTY ACQUISITION, DISPOSAL, INVENTORY MANAGEMENT • NAVY HOUSING MANAGEMENT • FACILITY PLANNING AND PROGRAMMING • FACILITY MAINTENANCE GUIDANCE • NUCLEAR SHORE POWER • AUTOMOTIVE, RAILWAY CONSTRUCTION, WEIGHT-HANDLING EQUIPMENT • NATURAL RESOURCES • POLLUTION CONTROL • NAVY SEABEE SUPPORT	• SUPPLY MANAGEMENT • PRINTING AND PUBLICATIONS • EXCHANGES, COMMISSARIES, SHIP STORES, FOOD SERVICE • FIELD PURCHASING MANAGEMENT • TRANSPORTATION MANAGEMENT • MOVEMENT OF HOUSEHOLD GOODS • MATERIAL HANDLING, FOOD SERVICE EQUIPMENT • NAVY STOCK FUND MANAGEMENT

The Naval Ship Systems Command divided R&D between the Deputy Commander for R&D and the Deputy Commander for Engineering. The Deputy Commander for R&D served as the focal point for all matters relating to RDT&E program and budget formulation and provided management for NAVSHIP's Research, Exploratory Development, and certain Advanced Development programs. The Deputy Commander for Engineering assumed responsibility for managing the function of ship design, ship system and equipment design, engineering procurement, and inventory management. He also provided financial management and funding for the Naval Ship Engineering Center (NAVSEC). NAVSEC was an adjunct to the NAVSHIP organization and had responsibility for ship system design and development. In addition, there was a Deputy Commander for Ship Acquisition who was responsible to the Commander for integrating, coordinating, and supporting all aspects of the ship acquisition program, including oversight of NAVSHIP's designated project managers.

The Naval Ordnance Systems Command organized its RDT&E function in a different manner. There was an Assistant Commander for Research and Technology who was responsible for planning, programming, and directing NAVORD research and

technology programs. System development, however, was organized along warfare lines. Initially, there were separate deputy commanders for ASW, anti-air warfare, strategic warfare systems, and surface warfare systems. The strategic systems directorate was never implemented, largely because of potential conflict with the Special Projects Office. Toward the end of the era, the three warfare directorates were merged under a single Deputy Commander for Systems and Acquisition.

The principal R&D offices in the Naval Air Systems Command were the Deputy Commander for Research and Technology and the Deputy Commander for Material Acquisition. The Deputy Commander for Research and Technology had responsibilities comparable to those of his counterparts in the other systems commands. The Deputy Commander for Material Acquisition handled the engineering development, evaluation, test, and production duties. The Airframe Division was the responsible organization within the material acquisition directorate for design and development of aircraft, air launched missiles, and other flight systems; it was subdivided into component groups for armament, avionics, ground support, propulsion, ship installations, and astronautics.

The Naval Electronics System Command closely resembled the Naval Air Systems Command. Planning and initiating Research and Exploratory Development programs was the responsibility of the Director for Research and Technology. The Deputy Commander for Material Acquisition planned and directed engineering developments and acquisitions.[37]

Navy Laboratories

In addition to the responsibility for directing the systems commands, the Chief of Naval Material was also given authority for certain corporate laboratories. The effort to upgrade the status of the laboratories, which began with the creation of the Director of Navy Laboratories, extended through the 1966 reorganization. As a result, certain laboratories were raised to the level of Class II activities, which meant that they reported directly to the CNM. The change placed these laboratories at the same level of their former sponsors, the systems commands. (See Chapter 8 for a discussion of the issues surrounding laboratory policy).[38]

DESIGNATED PROJECT MANAGERS IN THE NAVAL MATERIAL COMMAND

One of the priorities set forth in the 1966 reorganization was to reaffirm and strengthen the systems management approach to weapons development and acquisition. The CNM had the responsibility for designating project managers in cases where intensified management was required. Each project manager received a charter from CNM

that established the scope of his authority and the operating relationships with the systems commands. In cases where the project extended beyond the cognizance of a single system command, the project manager reported directly to the CNM, in other cases, the project manager reported to the appropriate system commander.[39]

The use of intensified management procedures clearly expanded under the reorganized material command. In the years 1966-69, the number of formal project management offices nearly trebled. It was the initial intent to apply project management strictly to the systems engineering phase in which costs were reasonably well defined and no major technical risks remained. Each project office was to have a clearly stated objective and a predictable length of life.

As time passed, intensified management began to be applied to efforts that were essentially program rather than project oriented. An examination of the 23 projects designated by the CNM between 1966 and 1973 found almost half to be program oriented. The distinction is important because program-oriented offices presented an entirely different set of circumstances for the R&D manager. In many cases, programs were heavily involved in the early developmental phases with large technical risks to overcome and uncertainty as to the ultimate procurement of the product. Consequently, the charters of these offices tended to be open ended, long lived, and supported by sizeable staffs.

The impact of program/project management on the functional organizations was great. On the financial side, more and more of the RDT&E budget was controlled by the program/project offices, thereby reducing the flexibility of the systems commanders. Moreover, because a few of the projects/programs occupied so much of the budget, the only real possibilities for reductions were those Research and Exploratory Development funds allotted to the systems commands. Finally, the program/project offices acted as a drain on the staff resources of the SYSCOM research and technology and acquisition groups.[40] The subject of project management is treated in further detail in Part V.

ORGANIZATIONAL ADJUSTMENTS IN THE OFFICE OF THE CHIEF OF NAVAL OPERATIONS 1966-1973

The 1966 reorganization eliminated the bilinear organizational structure which had served the Navy for more than 100 years. Under the terms of the reorganization, the Chief of Naval Operations assumed direct line authority over the material organization. This action ratified a trend that had been in motion since the late 1940's. The trend accelerated in the 1960's with the establishment of program directors to assume authority and direction over high priority areas. These and other changes in OPNAV are described in the sections below.

Director of Antisubmarine Warfare

The concept of program direction in OPNAV came into focus with the establishment of the ASW Program Director in May 1964. The creation of this office was the result of pressure from within and outside the Navy to develop a centralized authority for direction and control of the myriad ASW programs within the Department. Secretary Nitze named Vice Admiral Charles B. Martell, to be the first Director of Antisubmarine Warfare Program and gave him full authority to coordinate the entire ASW program. As Director, Martell was responsible for assessing potential submarine threats and for developing successive generations of ASW systems to meet those threats. He determined ASW requirements, established priorities of development, and maintained tight control over ASW R&D funds.[41]

Assisting the ASW Director was an ASW Systems Project Manager, established under the Chief of Naval Material. The ASW manager acted as a direct link in the chain of command emanating from the Director of ASW with the responsibility for coordinating all aspects of ASW work in the bureaus, systems commands, and laboratories.[42]

Other Program Directors

In 1967 Navy Secretary Paul Ignatius appointed Rear Admiral G.H. Miller as Director of Offensive and Defensive Systems. Miller was made responsible for centralized coordination of all strategic offensive and defensive force planning, programming, and appraising. Four years later the CNO disestablished the Offensive and Defensive Systems Directorate, and replaced it with separate organizations for electromagnetic program and command and support systems. The former directorate had responsiblity for determining requirements, establishing priorities, and appraising developments in the field of tactical electromagnetic systems. It remained a separate directorate until 1973, at which point its functions were transferred to the antisubmarine warfare office. The Command Support Directorate had similar responsibilities in the area of communications, intelligence, reconnaissance and surveillance readiness information, cryptology, security, and weather services.[43]

Office of the Oceanographer of the Navy

While somewhat different than the other program directors discussed in this section, the Office of the Oceanographer represented one approach to a complex organizational problem which concerned virtually all levels of R&D management in the Navy Department. Navy involvement in oceanography dated back to the Second World War, but it remained a relatively low priority item up through the 1950's. This fact was borne out in

a 1958 report of the President's Science Advisory Committee which noted that inadequate attention had been paid to the study of oceanography. In the early 1960's, the first Assistant Secretary (R&D) expressed considerable interest in the subject and went so far as to establish a separate staff on oceanography. Eventually, a separate organization for an oceanographer was established with a dual reporting relationship. The oceanographer received policy guidance from the Assistant Secretary and served as Naval Oceanographic Program Director for the Chief of Naval Operations. The charter of the office was broadly stated so as to give the incumbent a real measure of authority, including control of personnel and funds. Major research and development functions were made the responsibility of existing positions: the Chief of Naval Research served as Assistant for Ocean Sciences, and the Deputy Chief of Naval Material (Development) acted as Assistant for Ocean Engineering and Development.[44]

DCNO(Dev) Redesignated Director RDT&E

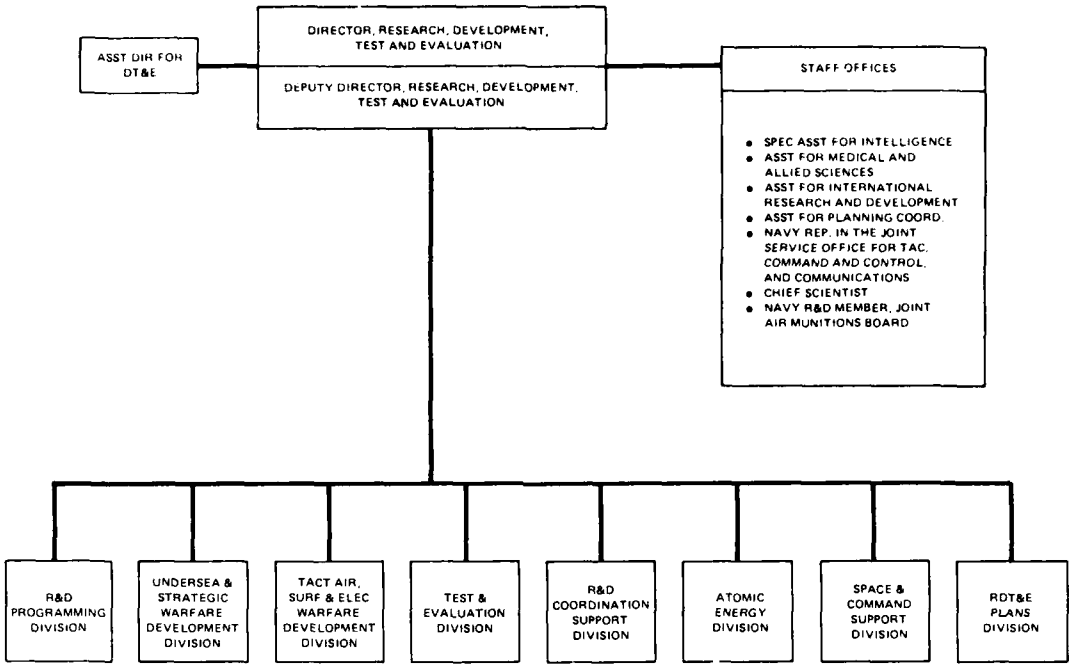
The trend of designating directors in certain program areas in OPNAV eventually reached the RDT&E program. In early 1971, Chief of Naval Operations Zumwalt decided to designate a Deputy Chief of Naval Operations for submarine warfare to complement the recently renamed Deputy Chiefs for Air and Surface Warfare. Given the fact that there was a statutory limit placed on the number of deputy chiefs, one of the existing deputy chiefs needed to be reassigned. Because of its program orientation, the CNO determined that the DCNO(Dev) be disestablished and redesignated as Director, Research, Development, Test, and Evaluation.

The change in organizational status did not bring about any measurable shift in responsibility, except that now there were three warfare areas with R&D responsibilities where previously there had been only two. The Director of RDT&E functioned principally as the coordinator of requirements determined by the warfare areas and as sponsor for the CNO of the RDT&E appropriation. His authority over research and development remained largely in the area of systems development and continued to be shared with the various warfare DCNOs and the other program directors.

As indicated in Exhibit I-29, the organization of the Director of RDT&E was divided into "operating" and "staff" units. The warfare divisions implemented the responsibilities of the Director for the coordination, integration, and direction of R&D programs in their specific areas, while staff divisions provided support for the planning and programming efforts.[45]

The interaction of the Director of RDT&E with the deputy chiefs, program sponsors, and the program planning directors, was complex and involved. Each of the

EXHIBIT I-29
Director of Research, Development, Test, and Evaluation 1972



aforementioned OPNAV organizations had a vested interest in the direction, planning, funding, and priorities of its particular area. Problems arose because the charters of the competing organizations inevitably overlapped. The function of the Director of RDT&E was to somehow coordinate these competing entities and develop an integrated and balanced RDT&E program. As appropriation sponsor, the office theoretically wielded the power to effectively execute this task, but in fact it never really became the strong instrument of decisionmaking its proponents had envisioned.

Additional Measures to Strengthen OPNAV Control

Beginning with the 1966 Reorganization, OPNAV became increasingly involved in the management of the budget. In 1970, a Fiscal Management Division was organized under the Director of Navy Program Planning. The objective of the division was to develop, coordinate, and maintain an integrated system of staff service in the financial management/controller area. In 1972, the budget authority of CNO was further amplified by the assignment of responsibility for all major Navy appropriations with the exception of RDT&E, which continued to be managed by the ASN(R&D).[47]

In an entirely different area, Chief of Naval Operations Elmo Zumwalt changed the composition of the CNO Advisory Board and renamed it the CNO Executive Board (CEB). The CEB was to serve as a forum for ideas; it coordinated the management actions necessary to execute approved programs and advised the CNO on matters of policy and strategy. Permanent members included the deputy chiefs, the directors of the major staff offices, the Chief of Naval Material, and other officials in OPNAV. In addition, there were associate members such as the commanders of the systems commands.[48] Admiral Zumwalt also designated an executive panel (CEP) comprised of a senior captain and a small staff to assist him in the review of the RDT&E program. Specifically, the CEP provided the last OPNAV review of the RDT&E budget prior to its submission to the Navy controller.[49]

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11. Ibid, pp. 99-101.

12. Ibid, p. 36.

13. Hal Bainford, "Navy Reorganization is only an Administrative Regrouping," *Armed Forces Management*, IX, No. 6 (June 1963), 22.

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20. DOD Directive 5010.14, Subject: System/Project Management, May 4, 1965.

21. SECNAV Instruction 5000.21A, Subject: Project Management in the Department of the Navy, September 8, 1965; NAVMAT Instruction 5000.5A, Subject: Project Management in NMSE, December 7, 1965.

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27. Memorandum from Paul H. Nitze, Secretary of the Navy, to Secretary of Defense, Subject: Management of Navy Laboratories, January 8, 1965.

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29. Personal Interview.

30. Chief of Naval Material, Farmington Conference Agreement, August,5, 1966.

31. "NMC Organization 'Pins' Responsibilities," *Armed Forces Management*, Vol. XII, No. 12 (September 1966), 71-77; Scott MacDonald, "How the Decisions were Made," Ibid., Vol. XII, No. 8 (May 1966), 74-79.

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34. Personal Interview.

35. ALNAV Note PO71707219, Subject: Reorganization of the Department of the Navy, April 24, 1966.

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SUMMARY

PRINCIPAL TRENDS IN HEADQUARTERS R&D ROLES AND RELATIONSHIPS 1946-1973

The Navy began the postwar era with a relatively simple and straightforward organization for research and development; the Chief of Naval Operations determined R&D requirements, and the material bureaus translated those requirements into hardware developments. R&D staffs were minimal and were generally subordinated to fleet readiness and material acquisition functions.

As evidenced by Exhibit I-30, the Navy headquarters R&D organization of 1973 bore scant resemblance to its predecessor of 1946. The primary force motivating this organizational upheaval was the elevation and centralization of authority and responsibility for R&D. A second force, the rapid advance in weapons technology, figured prominently in the appearance and widespread application of the so-called "systems approach" to the design and development of defense hardware and to R&D program management.

The numerous steps which brought the Navy from 1946 to 1973 are depicted in Exhibit I-31. Basically, the transformation that occurred in R&D headquarters organization can be presented in four fundamental areas:

- Shift of R&D authority to the Office of the Secretary of Defense
- Emergence of R&D staffs at each level of the Navy Department
- Appearance of special offices for intensified management of designated programs
- Replacement of the traditional bureau structure by the Naval Material Command.

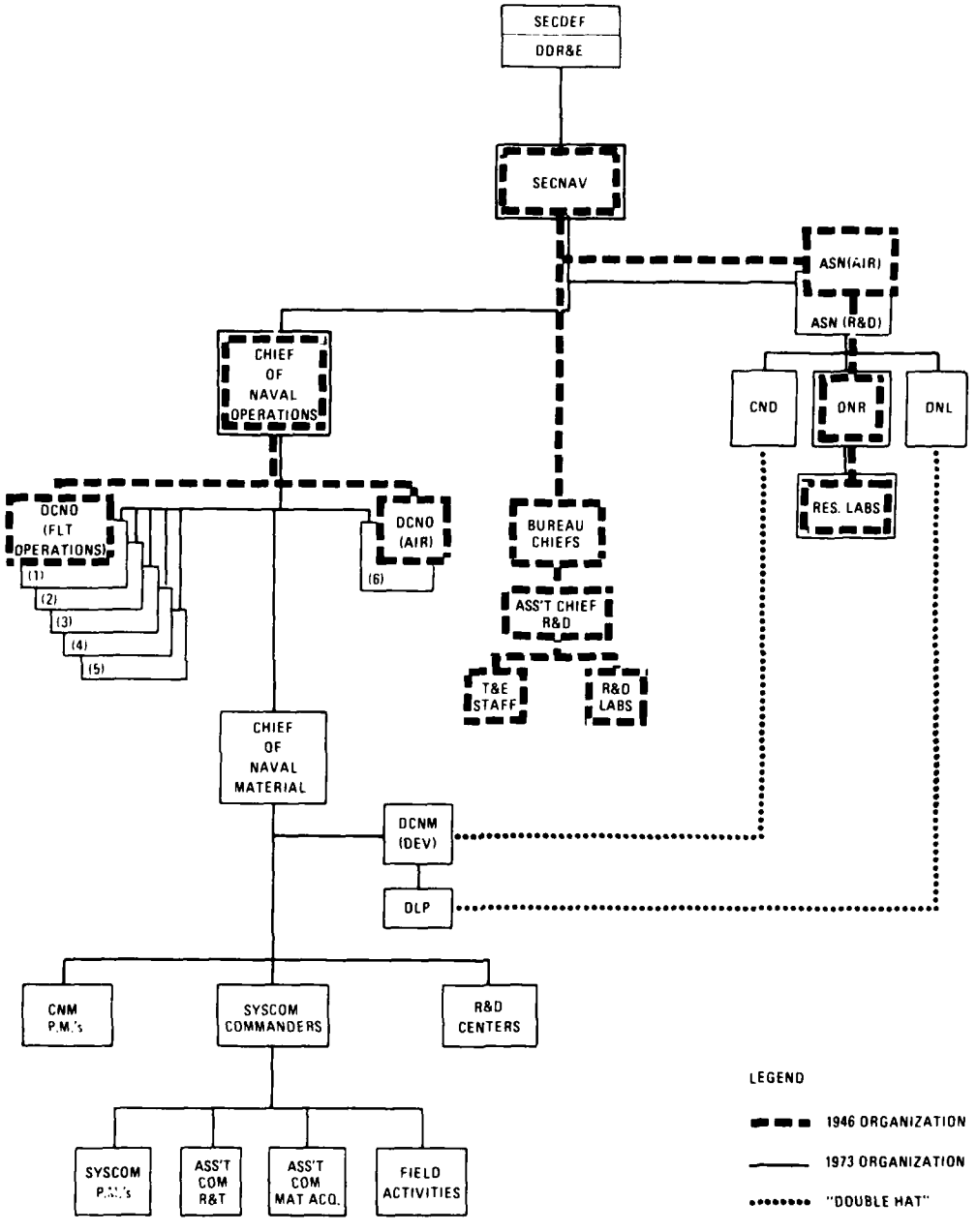
A discussion of each of these areas is provided in the following paragraphs.

SHIFT OF R&D AUTHORITY TO THE OFFICE OF THE SECRETARY OF DEFENSE

Prior to the National Security Act of 1947, coordination of Army and Navy R&D programs was accomplished by the Joint Research and Development Board and the

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EXHIBIT I-30
Navy Headquarters R&D Organization 1946 Through 1973



(1) DIR ASW
(2) DIR RDT&E
(3) DIR COMMAND SUPPORT
(4) OCNO (SURFACE WARFARE)
(5) OCNO (SUB WARFARE)
(6) OCNO (AIR WARFARE)

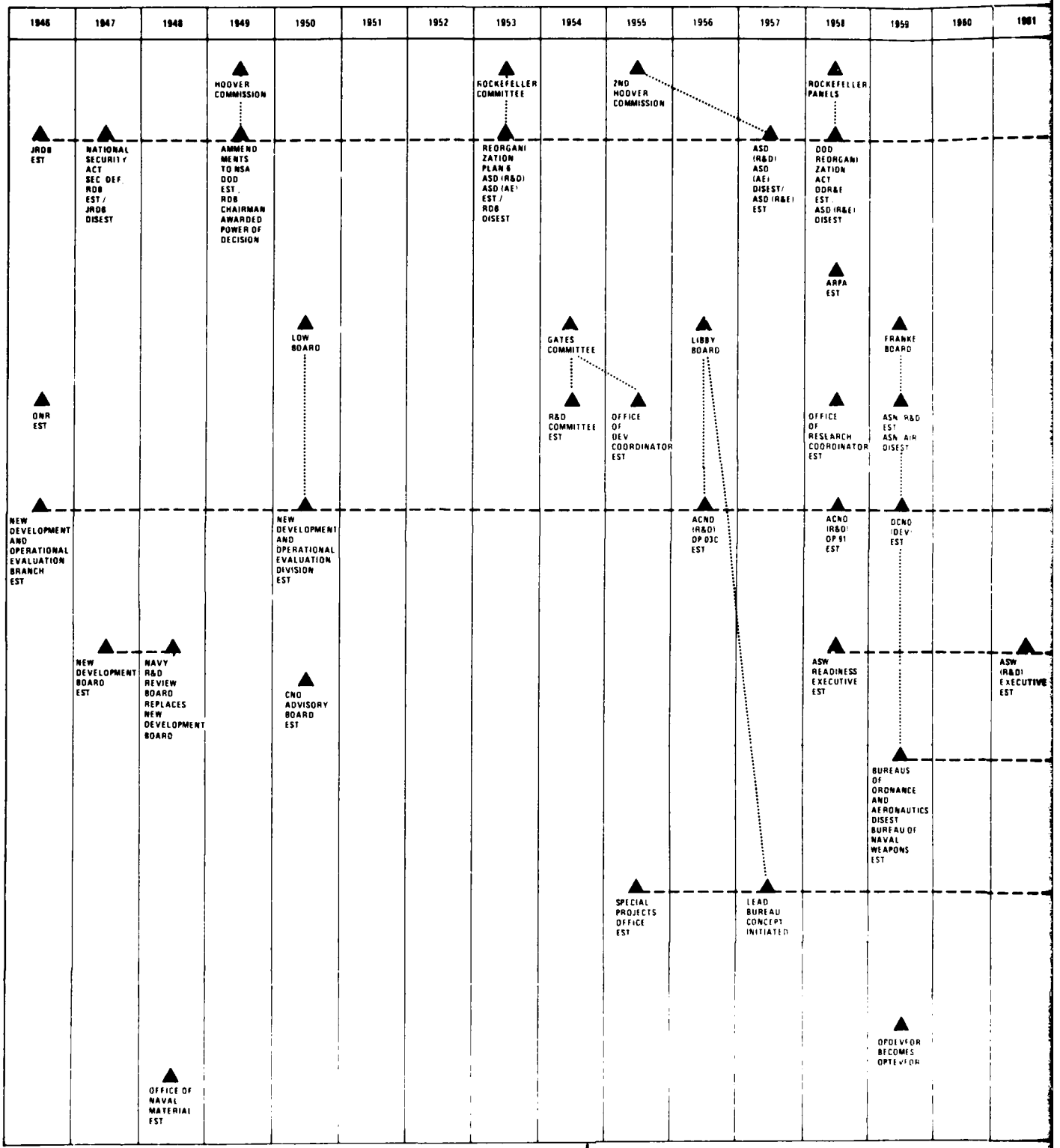
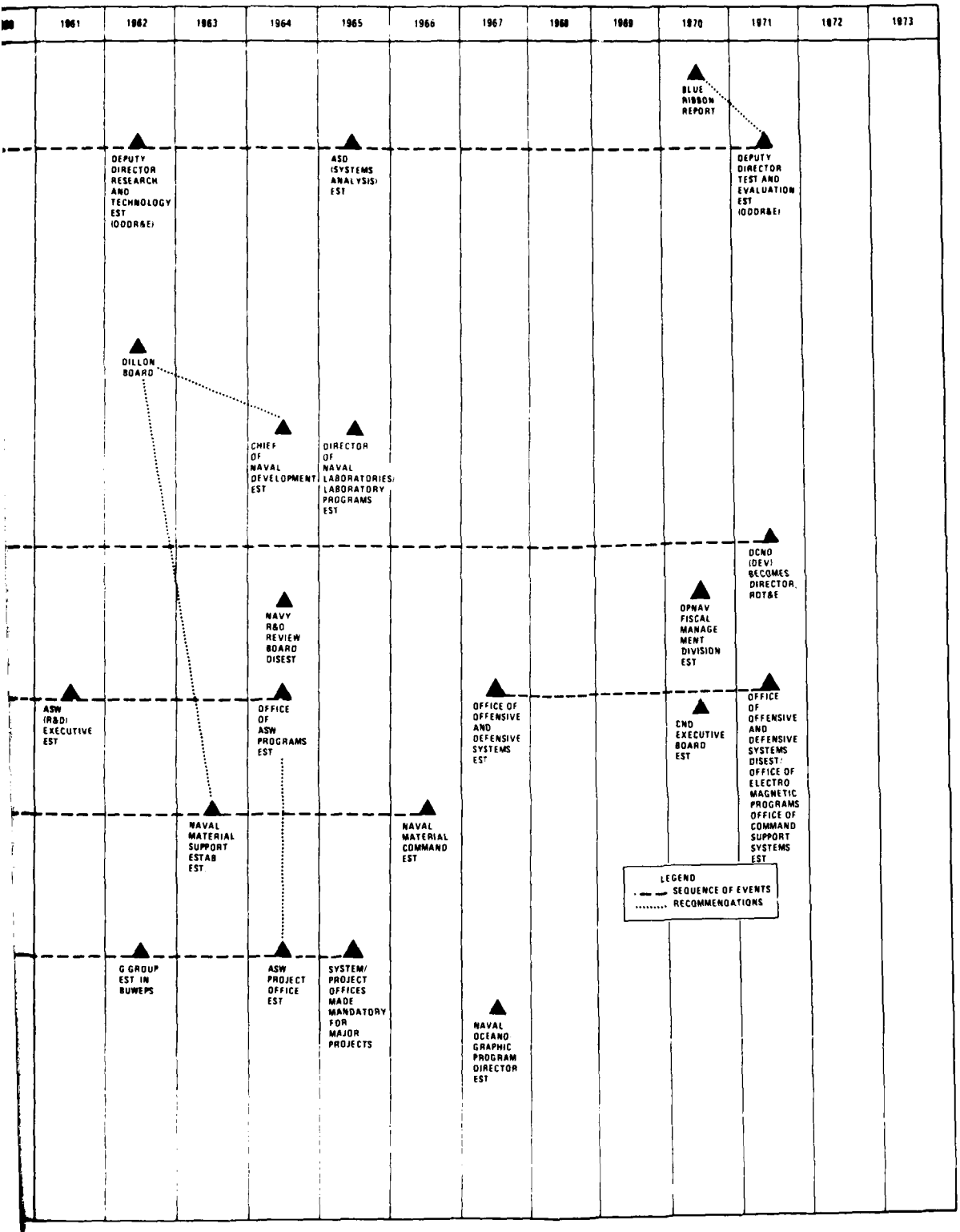

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AMMEND MENTS TO NSA DOD EST RDB CHAIRMAN AWARDED POWER OF DECISION
ROCKEFELLER COMMITTEE
REORGANI ZATION PLAN 6 ASD (R&D) ASD (AE) EST / RDB DISEST
2ND HOOVER COMMISSION
ASD (R&D) ASD (AE) DISEST/ ASD (R&E) EST
ROCKEFELLER PANELS
DOD REORGANI ZATION ACT ODR&E EST ASD (R&E) DISEST
ARPA EST
ONR EST
LOW BOARD
GATES COMMITTEE
R&D COMMITTEE EST
OFFICE OF DEV COORDINATOR EST
LIBBY BOARD
FRANKE BOARD
OFFICE OF RESEARCH COORDINATOR EST
ASN R&D EST ASN AIR DISEST
NEW DEVELOPMENT AND OPERATIONAL EVALUATION BRANCH EST
NEW DEVELOPMENT AND OPERATIONAL EVALUATION DIVISION EST
ACND (R&D) OP 03C EST
ACNO (R&D) OP 91 EST
DCNO (DEV) EST
NEW DEVELOPMENT BOARD EST
NAVY R&D REVIEW BOARD REPLACES NEW DEVELOPMENT BOARD
CNO ADVISORY BOARD EST
ASW READINESS EXECUTIVE EST
ASW (R&D) EXECUTIVE EST
BUREAUS OF ORDNANCE AND AERONAUTICS DISEST BUREAU OF NAVAL WEAPONS EST
SPECIAL PROJECTS OFFICE EST
LEAD BUREAU CONCEPT INITIATED
OFFICE OF NAVAL MATERIAL EST
OPDEVFOR BECOMES OPTEVFOR

EXHIBIT I-31
Significant Milestones for Headquarters R&D Roles and Relationships 1946-1973



Aeronautical Board. Both Boards established committees and panels to examine programs of mutual interest and make recommendations concerning Service responsibility. Because of the independent nature of the military departments, the Boards' influence depended on voluntary cooperation, and the decisions reached were not necessarily binding on the individual departments.

The National Security Act of 1947 gave the Secretary of Defense a mandate to "eliminate unnecessary duplication" in military R&D. As provided in the act, Secretary of Defense Forrestal established the Research and Development Board (RDB) and assigned it the duty of preparing and coordinating an integrated R&D program based on priorities, military objectives, and future weapons systems. In the RDB deliberations, Service participation was a critical element in the policy/decisionmaking process; only in cases of extreme disagreement was it expected that the Secretary of Defense would intervene.

The 1949 Amendments to the National Security Act, however, substantially increased the authority of the Secretary of Defense and his staff. The amendments reduced the status of the military departments, established firm procedural controls over the Defense Department budget, and gave the Chairman of the RDB power of decision in Board matters.

The DOD reorganization of 1953 eliminated the RDB and divided the R&D function between Assistant Secretaries of Defense for Research and Development and for Applications Engineering. The division of R&D responsibilities was accompanied by an increase in the authority of the assistant secretaries, most notably evident in the control and coordination of the defense R&D dollar. In 1957 the R&D function was returned to a single office for research and engineering.

One of the important features of the DOD reorganization of 1958 was the upgrading of the R&D authority of the Secretary of Defense. The Assistant Secretary for Research and Engineering was redesignated Director of Defense Research and Engineering and assigned supervisory authority and control over all research and engineering as well as direct control over any R&D project designated by the Secretary of Defense.

The pervasive authority delegated to DDR&E for research and development became fully evident in the 1960's. The centralization of R&D authority in DDR&E manifested itself in several ways, most notably in the detailed and critical examination of Service R&D programs. In the late 1960's and into the 1970's, steps were taken to reverse some of the centralization, but the basic premise that ultimate decisionmaking authority for defense R&D rested with the Office of the Secretary of Defense had long since ceased to be an issue.

EMERGENCE OF R&D STAFFS AT EAC H LEVEL OF THE NAVY DEPARTMENT

While line responsibility for R&D was clearly established in the Navy Department at the beginning of the era, R&D staffs were virtually nonexistent. In the Office of the Chief of Naval Operations, the organization with principal responsibility for coordinating R&D requirements was located at the branch level under the Deputy Chief of Naval Operations (Operations). The R&D responsibility of the Secretary of the Navy was but one of several assigned to the Assistant Secretary of the Navy for Air. Among the specific R&D duties delegated ASN(Air) was that of supervising the newly established Office of Naval Research (ONR).

Starting in the late 1940's, a more distinct R&D role in the Office of the Chief of Naval Operations began to emerge. The Navy R&D Review Board, established in 1948, served as the focal point in OPNAV for annual review of the R&D program. Following a Low Board (1950) recommendation, the CNO ordered the creation of a New Developments and Operational Evaluation Division to act as a central coordinating agency for Operational Requirements generated by the warfare desks. In 1956, the R&D responsibility was upgraded from the division level to the status of Assistant Chief of Naval Operations.

In the period from 1946 to 1958 the R&D function in the Office of the Secretary of the Navy also assumed more importance but remained a collateral function of ASN(Air). As a result of a Gates Committee (1954) recommendation, ASN(Air) was relieved of certain functions in order to devote more time to research and development. On the other hand, the Navy rejected the Hoover Commission (1955) recommendation that it follow the pattern of the Army and Air Force and designate an Assistant Secretary for R&D. A Navy study in 1956 concluded that the assignment of R&D to an assistant secretary with broader management responsibilities returned dividends in both the R&D and production fields. This position was reversed following the DOD Reorganization Act of 1958. Within the year both an Assistant Secretary of the Navy for R&D and a Deputy Chief of Naval Operations for Development were established. The former was assigned overall responsibility for the R&D program and designated manager of the RDT&E appropriation; the latter was made the responsible official in OPNAV for coordinating and integrating the RDT&E program.

The changes in the Navy material organization effected in the mid-1960's prompted the designation of additional R&D staff through the creation of the Deputy Chief of Naval Material [DCNM(Dev)]. In 1964 DCNM(Dev) was given the additional assignment as Chief of Naval Development to assist the ASN(R&D) in coordinating Exploratory Development programs. Concern for the "protection" of Exploratory Development was also evident in the 1966 reorganization by the division of the RDT&E function in the systems commands between separate organizations for research and technology and material acquisition.

The 1966 reorganization set the stage for greater CNO involvement in material affairs which in turn translated into additional OPNAV staff with RDT&E responsibilities. Starting with antisubmarine warfare, CNO designated program directors with authority and direction over high priority areas. Over the years, program directors were established in the areas of strategic systems, electromagnetic programming, and command and support systems. In 1971 CNO extended the concept further with the disestablishment of the billet of DCNO(Dev) and the creation of a Director of RDT&E.

APPEARANCE OF SPECIAL OFFICES FOR INTENSIFIED MANAGEMENT OF DESIGNATED PROGRAMS

In the mid-1950's, the emerging "systems approach" began to exert a profound influence on the traditional bureau organization which ultimately led to a dramatic realignment of responsibility and authority for project management. The establishment of the Special Projects Office (1955) represented a radical departure from the conventional organization and management of a high priority weapons system. Organized outside the bureau structure, the Special Projects Office had broad authority to meet its objective, including a direct reporting relationship with the Secretary of the Navy and a special management fund.

Beginning in 1955, the Bureaus of Aeronautics and Ordnance both made organizational changes to strengthen the systems approach to weapons management. The Bureau of Ordnance reorganized its R&D group along systems lines, while the Bureau of Aeronautics established program managers to effect overall coordination across functional groups. When the two bureaus merged in 1959, project management techniques were further refined. An Assistant Chief for Program Management was established and assigned program management responsibility for BuWeps R&D programs. There were, however, problems which lay beyond the direct authority of the bureau chief, and the establishment of a second specially designated office to assume responsibility for surface missiles indicated that there was still no coordinating authority outside of the Secretary of the Navy capable of resolving interbureau technical difficulties.

The Navy attempted to resolve this problem by giving the Chief of Naval Material coordinating authority over the material bureaus. Project management was emphasized by the CNM, and several major projects were chartered under his authority. In 1965, the Office of the Secretary of Defense formalized its policy on project management and made the establishment of system/project offices mandatory for all high priority projects as well as for those which exceeded certain cost boundaries.

The following year, the Navy completely reorganized its material bureaus and established an organizational framework within which projects crossing command lines could function. As a result of the OSD mandate and the reorganization, the number of project offices significantly expanded. In 1973, there were 10 project management offices operating under CNM charters and 45 operating under system command charters.

The original intent of intensified management was to direct it toward specific projects, but the practice rapidly expanded to encompass work in program areas. A Program Director for Antisubmarine Warfare was established in 1964 in the Office of the Chief of Naval Operations and a counterpart, the ASW Program Management Office, was set up in the material organization. Over the years the Special Projects Office established for a specific system became the Strategic Systems Project Office. In 1973, at least 25 of the 55 "project managers" had broad program responsibilities as distinguished from responsibility for individual, highly focused projects.

REPLACEMENT OF THE TRADITIONAL BUREAU STRUCTURE BY THE NAVAL MATERIAL COMMAND

Dating back to the mid-19th century, the bureaus served as agents of the Secretary of the Navy providing for the material needs of the Operating Forces. They had a direct reporting relationship with the Secretary and enjoyed virtual autonomy in technical and business management matters. Fundamental problems emerged in the 1950's which placed the bureaus increasingly on the defensive. Interfaces between the respective product areas became more troublesome as evidenced by the dispute between the Bureaus of Ordnance and Aeronautics over cognizance for guided missiles. More importantly, the centralization of decisionmaking in the Office of the Secretary of Defense and in OPNAV and SECNAV was at variance with the independence and autonomy traditionally exercised by the bureau chiefs.

Following the creation of the Special Projects Office, the Chief of Naval Operations ordered a study of the adequacy of the bureau system of organization. The Libby Board recommended that no basic change in the bureau system be made. To resolve cognizance disputes, it proposed designating a lead bureau to assume primary responsibility for development.

Three years later, the Franke Board reversed the Libby Board decision and merged the Bureaus of Ordnance and Aeronautics into the Bureau of Naval Weapons. By placing two-thirds of the R&D resources in a single bureau, the Franke Board hoped to eliminate cognizance disputes as well as the need for specially designated project offices.

The trend toward centralized control of the material organization rapidly accelerated in the 1960's. Contributing to the momentum for centralization were a new round of cognizance disputes, the designation of a second special designated project office, and a growing popularity of the use of program/project management tools.

A comprehensive study of the material organization, conducted in 1962, found that the lead bureau concept failed to resolve differences among the coequal and autonomous bureau chiefs. To remedy the situation, the Dillon Board proposed federating the material bureaus under the coordinating authority of the Chief of Naval Material. Based on the Dillon Board recommendations, the material bureaus were joined into the Naval Material Support Establishment (1963). In spite of the move, certain fundamental management questions remained unresolved: the concentration of technical responsibility and resources in the Bureaus of Ships and Naval Weapons made effective management along technology lines difficult to accomplish; the coordinating authority vested in the CNM was insufficient to the task of successfully directing the efforts of the material organization.

In 1966 the material structure was completely reorganized. The four material bureaus were divided into six systems commands; the Chief of Naval Material assumed command responsibility for the material organization but now reported to the Chief of Naval Operations rather than the Secretary. The reorganization strengthened program management and facilitated the direction of programs that crossed organizational lines. It also placed two layers of review between the material organization and the Secretary of the Navy.

COMMENTARY

Among those interviewed, there was concern expressed that the proliferation of R&D organizations resulted in a serious compromise of the relationship between authority and responsibility. Many accepted the creation of the Office of the Secretary of Defense and a measure of centralized control as necessary in view of complex inter-Service issues and the magnitude of resource commitments. What they found troubling was the proliferation of staffs and reviewing authorities at virtually all levels who were able to insert themselves in the decisionmaking process with little or no accountability for the success or failure of an endeavor.

The interviewees also noted that the removal of statutory constraints to organizational change accelerated the tendency to seek organizational solutions to virtually all problems. Each change traded one organizational interface for another and disrupted the continuity of purpose so essential to effective R&D management. Moreover, the syndrome appeared to be self-perpetuating. Faced with a seemingly ineffective functional

structure, many argued that the only way they could get anything accomplished was to organize special management arrangements for task teams and project offices that could operate outside the functional framework.

PART II

NAVY RDT&E FIELD ACTIVITIES

The Navy's tradition of establishing and maintaining research and development laboratories and other field activities to support its major missions dates back to the early 19th century. Significant among the earliest Navy R&D facilities were the small observatory which was converted into the Naval Observatory and Hydrographical Office in 1842 and the first experimental firing range established on the Anacostia River in 1848. At the turn of the century, the David Taylor Model Basin was opened at the Washington Navy Yard. The exigencies of World War I brought about the expansion of the Navy Yard's facilities to include the Naval Research Laboratory, the Naval Ordnance Laboratory, and the Naval Weapons Laboratory's forerunner to conduct scientific, developmental, and test work related to naval warfare problems. Consistent with the basic management concepts prevalent in the Navy throughout the early post-World War II years, these laboratories and facilities were responsible to designated bureaus, which maintained them and utilized them in carrying out their mission responsibilities.

The practice of utilizing civilian scientists and engineers to assist the Navy with its technical problems also began in the late 19th century with the appointment in 1864 by the Secretary of the Navy of a Civilian Commission on Practical Engineering. The use of both civilian expertise and in-house R&D activities expanded throughout the early 20th century, accelerated especially by the two world wars.*

The experience of World War II and the unqualified success of the Office of Scientific Research and Development (OSRD) in coupling civilian scientific competence with military R&D requirements lent emphasis and support to the concept of maintaining in-house defense R&D capabilities. In the first two decades after the war, the number of Navy RDT&E field activities burgeoned, accompanied by a corresponding increase in attention to them at all levels of government.

During that period, solid accomplishments realized in the Navy's in-house R&D complex in the areas of nuclear propulsion, radar, guided missiles, jet aircraft, tactical and ASW weapons, were some measure of its effectiveness. Looking back, this success could be at least partly attributed to close working relationships with parent bureaus and offices and relatively direct lines of responsibility and authority. Nevertheless, even in the early postwar years, there was evidence of the existence of incipient problems which were to increasingly plague the activities. In the late sixties and early seventies, these problems

* For a good, concise review of pre-World War II research and development, see Julius Furer, *Administrative History of the Navy Department in World War II* (Washington, D.C., 1959) Chapter XIX.

matured, interest in and attention to the in-house activities grew concurrently, and emphasis was increasingly placed on improving their quality and efficiency and reducing their numbers through consolidation.

The character and makeup of the Navy R&D field activities evolved throughout the postwar years; they performed many different kinds of tasks and included various types of facilities. Nevertheless, throughout most of the era, Navy R&D activities were broadly definable in the following major categories:

- *Naval Research Laboratory (NRL).* Unique among the Navy's RDT&E field activities, NRL became the Navy's "corporate laboratory," focusing on basic and applied research of Navy-wide relevance in the physical sciences.

- *Laboratories reporting to the Bureau of Medicine and Surgery and the Bureau of Naval Personnel.* These laboratories were involved primarily in research and the early development stages of medical sciences and personnel motivation and training.

- *Research and development laboratories of the material bureaus.* These laboratories and technical activities were concerned with development of new naval weapons systems and components, as well as support and improvement of those already in the fleet. Each of these laboratories generally concentrated on one aspect of naval requirements, e.g., ordnance, electronics, aeronautics, etc., which was tailored to meet the needs and support the mission of the bureau to which it reported. Nevertheless, some overlapping inevitably occurred and increased as systems became more complex and technologically interrelated.

- *Test and engineering stations.* Technical activities at these stations concentrated on developmental test and evaluation of new weapons systems, as well as on engineering support and maintenance of in-service equipment. Test and evaluation activities became involved, in varying degrees, in related development work.

- *Government-owned, contractor-operated R&D activities (GOCOs).* These activities, their facilities, and land were entirely owned and controlled by the Navy Department, but they were operated under contract by nongovernment organizations, companies, universities, or other institutions. They were generally established where the Navy required complex, costly, or highly specialized facilities, but didn't have sufficient personnel to staff them. Through GOCOs, the Navy gained the advantages of flexibility with respect to staffing, organization, and management inherent in civilian university and

industry organizations but maintained the control inherent in "captive" government/military activities.

- *Federal Contract Research Centers (FCRCs).* The concept of FCRCs was initiated in the early sixties. They were specifically designated, nongovernment-owned activities which performed major assignments or acted as "task centers" under contract to government agencies. The key element was usually a specific scientific or engineering personnel unit, generally associated with a university or institute, and operated on a non-civil service basis. The government often provided facilities. FCRCs provided a ready, competent research organization to perform a particular task.

While all of the bureaus had some facilities and/or laboratories, as indicated in Part I, somewhere between 95 percent and 97 percent of all Navy RDT&E was conducted by the Office of Naval Research and the three material bureaus (Aeronautics, Ships, and Ordnance). Part II will therefore be confined to a discussion of RDT&E field activities of those four organizations and fundamental management issues related to them. The laboratory role in planning and execution of Navy RDT&E programs is discussed in Parts III and V, respectively.

CHAPTER 7

NAVY RDT&E FIELD ACTIVITY ROLES AND RELATIONSHIPS 1946-1958

While the conduct of in-house military research, development, test, and evaluation was never seriously challenged after World War II, a number of significant issues bearing on the maintenance, utilization, and management of in-house activities were raised. Chief among them was the appropriate role of military in-house laboratories* vis-a-vis outside performers [industry, universities, nonprofit institutions and government-owned, contractor-operated (GOCO) facilities]. Second was the means for improving defense laboratories to counteract inherent difficulties in attracting and retaining technical talent in the military environment. Issues specific to the Department of the Navy involved relationships between the RDT&E field activities and headquarters organizations, and precise definition of the activities' missions and assignments.

This chapter describes the principal Navy RDT&E field activities between 1946 and 1958: their roles and relationships; headquarters policies regarding their maintenance, utilization, and management; and the major laboratory issues that emerged in the early postwar period.

FUNDAMENTAL ROLES OF NAVY RDT&E ACTIVITIES

The prime function of the RDT&E activities was consistently to support the material bureaus' fleet-support missions by conducting research, development, test, and evaluation for the improvement of naval capabilities, equipments, and systems. In fact, to the extent that there was any top-level Navy Department policy at all regarding the in-house RDT&E activities in the immediate postwar years, it was embodied in the basic concept and the further generalization that the Office of Naval Research and the material bureaus should pursue an active R&D program "to improve Navy material and techniques to the maximum degree possible" both within naval establishments and by contract with outside agencies. Within that framework (which remained constant throughout the era), the Secretary of the Navy in 1946 also emphasized the need to produce weapons, devices, systems, and techniques economically and to eliminate duplication of effort.[1]

* "Laboratories" is often used in this Part to refer in a general sense to all research, development, test, and evaluation activities.

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While not incorporated in any official directive or instruction, the following slightly more specific roles were defined from time to time by top-level Navy officials as appropriate reasons for the maintenance and utilization of the RDT&E in-house capability:

- To analyze specific needs of the fleet and provide a quick-response standby capability.

- To maintain a sufficient base of scientific and engineering talent to act as a technical memory and conscience as well as to identify and apply the newest technology to generate military weapons and systems. This implies responsiveness to the peculiar mission and environment of the Navy as well as proof against overreliance on outside sources.

- To provide the Navy with objective competence necessary to analyze, evaluate, test, and acquire sophisticated weapons systems. This includes evaluation, monitoring, and direction of complex proposals and contracts no matter what their origin.

- To permit maximum flexibility, e.g., in initiating (or cancelling) high-risk technical projects without entanglements of contract litigation.

- To ensure the capability to do "pedestrian," or unchallenging, but vital work; high-grade support and maintenance of deployed systems, and sensitive R&D under tight security controls.

- To furnish a developmental cost yardstick against which to evaluate work performed by industry as well as to provide the ability to "trouble shoot" problems encountered by contractors.[2]

RELATIONSHIPS BETWEEN RDT&E FIELD ACTIVITIES AND HEADQUARTERS ORGANIZATIONS

By virtue of his authority over the entire research and development program, the Assistant Secretary of the Navy (Air) technically had overall management responsibility for the in-house laboratory complex. In fact, the ASN(Air) incumbents did little, if anything, to exercise active control over the activities. Their authority was through the bureau chiefs, who had direct control over the laboratories' funds. This management relationship was maintained throughout the 1950's.

As described in Part I, military command of RDT&E field activities was exercised via District Commandants, whose duties were most often restricted to matters of security,

intelligence, discipline, and naval communications. While many considered the military chain of command almost a service to the laboratories, others viewed it as a potential source of conflict with the management and technical direction responsibilities of the bureaus and offices.[3]

There was a careful distinction between military command, described above, and management and technical control of the Navy's RDT&E in-house activities. These latter functions rested exclusively with the bureaus and offices which were assigned cognizance over the field activities by the Secretary of the Navy. The major R&D laboratories of the Navy Shore Establishment in 1946 (listed in Exhibit II-1), were established specifically to support functional responsibilities of the bureau chiefs and the Chief of Naval Research. As a result, the field activities of a given bureau reflected and were closely related to the material responsibility of the bureau and the characteristics of the industry with which they necessarily interacted. For example, BuShips' in-house laboratories were often collocated with a shipyard and conducted testing in support of its work; because of an existing major aeronautical industrial capability in design and development, BuAer's activities tended almost exclusively toward test and evaluation. In fact, in the forties and fifties, there was a heavy orientation throughout the Navy's in-house activities toward testing capability, which reflected a continuation of patterns established in industry and defense activities during the war.

In general, the decade following 1946 also saw the planning and installation of major R&D facilities, such as the large transonic, supersonic, and hypersonic tunnels at the David Taylor Model Basin; the supersonic tunnel and ramjet test facility at the Naval Air Missile Test Center (Pt. Mugu); the inertial development and test facility at the Naval Air Development Center (Warminster, Pa.); the water tunnel at Penn State University; and the wind tunnels at NOL, APL (Johns Hopkins), and the Ordnance Aerophysics Laboratory (OAL) (Daingerfield). With the exception of OAL, these major facilities were installed at places where strong technology groups existed, and where interests and missions led to the facility concepts in the first place.

The existence of these facilities strengthened the position of the various in-house and university-affiliated laboratories as a complement to industry. They also served to focus the laboratories' roles and missions. At the same time, maximum usefulness of these major facilities and the technical groups that exploited them sometimes required substantial and continual funding, and their existence tended to hamper later attempts to restructure or consolidate laboratories.

The RDT&E field activities were subject to all general department-wide directives and instructions (e.g., regarding budgeting, programming, and reporting), but there was virtually no critical direction or review of policies from above. For all intents and purposes, the Navy field activities were administered through a single direct line of

EXHIBIT II-1
Principal Naval Research and Development Activities

OFFICE OF RESEARCH AND INVENTIONS/OFFICE OF NAVAL RESEARCH

Naval Research Laboratory, Anacostia Station, D.C. (1923)*
- Chesapeake Bay Annex, Chesapeake, Md.
- Boston Branch, Boston, Mass.
- Minneapolis Branch, Minneapolis, Minn.
- Underwater Sound Reference Laboratory, Orlando, Fla., and Mountain Lakes, N.J.

Special Devices Division, Sands Point, Long Island, N.Y. (1941)

BUREAU OF SHIPS

David Taylor Model Basin, Carderock, Md. (1940)*
Experimental Diving Unit, Navy Yard, Washington, D.C.*
Engineering Experiment Station, Annapolis, Md. (1903)
Naval Boiler and Turbine Laboratory, Navy Yard, Phila., Pa. (1909)
U.S. Navy Underwater Sound Laboratory, New London, Conn. (1946)
Naval Electronics Laboratory, San Diego, Calif. (1945)
United States Navy Material Laboratory, Navy Yard, New York (1922)
Industrial Testing Laboratory, Navy Yard, Philadelphia, Pa. (1933)
United States Navy Metals Laboratory, Munhall, Pa.
Navy Radiological Defense Laboratory, San Francisco, Calif. (1946)
Naval Mine Countermeasures Station, Panama City, Fla. (1945)

BUREAU OF AERONAUTICS

Naval Air Material Center, Philadelphia, Pa. (1943) ***
- Naval Air Experimental Station, Philadelphia, Pa.
- Naval Aircraft Modification Unit, Johnsville, Pa. (1944)
- Naval Auxiliary Air Station, Weston Field, Pa.
- Naval Aircraft Factory

Naval Air Station, Patuxent River, Md. (1945)
Naval Air Missile Test Center, Point Mugu, Calif. (1946)

BUREAU OF ORDNANCE

Naval Proving Ground, Dahlgren, Va.
Naval Powder Factory, Indian Head, Md.
United States Naval Ordnance Test Station, Inyokern, Calif. (1943)
Naval Ordnance Test Station, California Institute of Technology, Pasadena, Calif. (1941)**
Naval Ordnance Laboratory, Navy Yard, Washington, D.C., and White Oak, Md. (1919)*
Explosives Investigation Laboratory, Indian Head, Md., and Port Townsend, Wash.
Naval Torpedo Stations, Newport, R.I.; Keyport, Wash.; and Alexandria, Va. (1869)
Ordnance Aerophysics Laboratory, Daingerfield, Texas (1945)
Ordnance Research Laboratory, Pennsylvania State College, State College, Pa.**
Naval Ordnance Development Unit, Applied Physics Laboratory, Johns Hopkins Univ., Silver Spring, Md. (1942)**
Applied Physics Laboratory, University of Washington, Seattle, Washington (1943)**
Naval Aviation Ordnance Test Station, Chincoteague, Va.
Naval Mine Warfare Test Station, Solomons, Md.
Demolition Research Unit, Amphibious Training Base, Fort Pierce, Fla.
Allegany Ballistics Laboratory, (Cumberland, Md.)**

*Originally part of the Washington Navy Yard established in 1899.
**GOCO Activities
***Included six R&D Laboratories
Note: Establishment dates are included, where available.

Source: Navy Appropriation Bill, 1947. Hearings before the subcommittee of the Committee on Appropriations, House of Representatives, 79th Congress, 2nd Session, Part 1 (GPO, 1946); and Personal Interviews.

responsibility and authority vested in the powerful bureau chiefs.[4] This decentralized management and control of the laboratory complex was a recognition of the parent bureaus' disparate needs, which the laboratories were intended to serve.

The bureaus enjoyed and later fought to maintain their exclusive authority and control over the field activities on the grounds that it ensured responsiveness. The laboratories were often ambivalent about it. While they enjoyed the paternal aspects of the system (e.g., its assurance of funding, maintenance, and "protection,"), they chafed at their parent bureaus' use of them as "captive job shops" and their own lack of control over the technical programs. Some laboratory technical directors considered the absence, at headquarters level, of a central figure to focus on and resolve laboratory problems a major difficulty.[5]

A natural function of the decentralization of laboratory management was the evolution of divergent approaches to organization, control, and personnel and work assignments to the activities. For example, some were internally organized according to individual projects, while others were organized into functional (technology) areas. Crucial differences also existed in the relationship and relative control of the military and civilian chains, differences that tended to reflect both the bureau-sponsor and activity's mission. In this matter, there was a conscious effort to tailor the organization to the activity's mission; at the research end of the spectrum, for example, the civilian organization generally predominated. Conversely, where the function was clearly military, e.g., test and evaluation or ordnance, the military organization prevailed.[6] The following sections highlight the significant differences in management philosophy and organization of the Office of Naval Research and the three material bureaus in the decade following World War II.

Office of Naval Research

The transfer of functions and authority from the Office of Research and Inventions to the newly created Office of Naval Research in 1946 (see Part I) included responsibility for the Naval Research Laboratory (operated during the war by the Bureau of Ships) and the Special Devices Division (formerly under the aegis of the Bureau of Aeronautics). During the next year when OSRD was dissolved, ONR also took over its records and functions as well as much of its technical manpower and responsibility for continuing its work.

NRL was unique among the Navy's in-house laboratories. It had been established by an Act of Congress in 1923 as the first national laboratory devoted exclusively to research in the military sciences and was originally conceived to report directly to the Navy Secretary to insulate it from the production problems of the bureaus. It was also the only

laboratory established to conduct research applicable to the entire Navy. For a decade, NRL was shifted between the Secretary and bureau control. Its assignment in 1946 to ONR, reporting directly to the Chief of Naval Research, represented a return to the original concept of NRL as the Navy's "corporate laboratory," to carry out projects initiated by all the material bureaus.[7]

With its broad mandate, NRL enjoyed maximum freedom and autonomy. Since its primary focus was basic research, working details between the laboratory and ONR were handled by the corresponding scientific disciplines in each organization. Furthermore, while the director and those in charge of NRL's "housekeeping and support" and liaison functions were military officers, the heart of the organization (the Research Department) was headed and completely staffed with civilian scientists who unequivocally made all the technical decisions.[8]

The other activity transferred to the jurisdiction of CNR in 1946 was the Special Devices Division. Established originally in the Bureau of Aeronautics to develop simulators and training devices, its mission was also unusual in that most of its work was contracted out (according to specifications) and went further toward the procurement of production devices and their installation and maintenance in the field than projects in other laboratores. Its transfer to ONR was considered by some observers to be inconsistent with the research mission of the Office. The Division's Navy-wide work, efforts by the new CNR (due partly to the Division's "usefulness as a source of funding"), and possibly the "lack of extreme enthusiasm on the part of its former parent bureau" were cited as reasons for its assignment to ONR.[9]

The tendency of the Division's mission toward the test and procurement end of the RDT&E spectrum (as well as its previous association with and continued orientation toward the Bureau of Aeronautics) was reflected in the predominance of the military directorate over technical advisors, a situation that resulted in the resignation of at least one technical director.[10] Later changed to the Naval Training Device Center, it was represented in ONR by a liaison office that handled administrative details, including those with the user bureaus.

Bureau of Ordnance

Among the material bureaus, BuOrd had the most comprehensive RDT&E field complex and utilized it extensively, both in the early development stages and for technical direction of contractors.

The major BuOrd activities were built up after the war around the laboratories at China Lake [run by the California Institute of Technology (Cal Tech) under OSRD until 1945] and at the Washington Navy Yard [the Naval Ordnance Laboratory (NOL), part of

the Naval gun Factory]. BuOrd also assumed responsibility for what had been the Fuze Section of NDRC, including management of APL and ORL (two GOCOs). The experience of the war had convinced BuOrd decisionmakers that in-house technical competence was necessary to avoid the "frantic" unpreparedness that characterized the start of World War II. In addition, ordnance technology was now advancing rapidly, due especially to the war effort, but industry could not necessarily be counted upon to continue necessary development due to the unique military nature of ordnance work, i.e., explosive, often secret, and sometimes unacceptable to outside performers.

In 1948, NOL was moved to new facilities which had been build at White Oak, and its mission was expanded from wartime research, development, and evaluation to include work transferred from former OSRD laboratories at Brewston and Woods Hole. The laboratory at China Lake was also assimilated as the Naval Ordnance Test Station (NOTS).* In forming the postwar Ordnance laboratory complex, Admiral Hussey, Chief of the Bureau, approved charters that reflected joint civilian/military responsibility for technical programs, thereby establishing the principle of civilian influence in the laboratory (discussed below) and also decentralization within the bureau. In practice, this meant the laboratories often initiated technical projects: they wrote task assignments and forwarded them to the bureau where they were reviewed and approved (or not) for funding and returned to the laboratory.

Overall responsibility at the bureau level was exercised by the Assistant Chief of the Bureau of Ordnance (Research), who provided overall supervision to the laboratories and occasionally visited all R&D activities to inspect on-going work. Detailed guidance in specialized areas was provided by assistants and project officers. Control over areas of technological emphasis, duplication, and level of effort was exercised via funding decisions.[11] While a major thrust in BuOrd was consciously to give the laboratories maximum flexibility, the basic need to control the flow of funds prompted Admiral Hussey to set up four "desks" to keep track of allocations and facilitate reallocation. Nevertheless, direct lines of communication between laboratory directors and the Bureau Chief, who had total authority to act and make allocations, permitted timely management decisions.

BuOrd laboratories were managed internally on the basis of joint responsibility between the military commander and the technical director. The commanding officer, who often had a graduate degree in engineering or scientific areas, set policies and acted as liaison with outside authorities. The technical director or senior scientist was in a position of line authority to run the program, which included signing directives for spending money on the technical program. The blending of the two professions into an unusually successful civilian/military relationship at the principal BuOrd activities, NOL and NOTS, was attributed by NOL's postwar Technical Director, Dr. Ralph Bennett,

* Cal Tech's wartime capabilities also spawned two other postwar organizations: JPL, (a GOCO), and AeroJet (a commercial company).

largely to the following fundamentals of the laboratories' operating principles (written in 1946 and approved by the Chief of the Bureau of Ordnance in 1947):

- Laboratory participation in planning an integrated program
- Assignment of responsibility for all phases of laboratory operation to the commanding officer; delegation of responsibility for the technical program to the civilian technical director
- Joint responsibility for the effective and economical internal functioning of the laboratory to the military commander and the technical director
- Functioning of service departments primarily to supply needs of technical staff in accomplishing work specified by the technical director.[12]

The strength of the arrangement lay in its joint responsibility, with the technical program placed squarely in the hands of the civilian technical director. Coincidentally, it provided program continuity which was often compromised at other installations due to the rotation of military officers. Dr. Bennett pointed out in 1954 that the effectiveness of the principles still depended "very completely and in a very real way on cordial relationships between the technical director and the commanding officer. . .but I see no other laboratory or station of this type which I have felt is working better, or really as well as ours."[13] Many in the Navy R&D community agreed. The unequalled success of the military/civilian relationship at NOL and NOTS led to the embodiment of their operating principles, as a prototype for all Navy laboratories, in the 1963 directive on management of the in-house laboratories (see Chapter 8).

In the late forties, proposals by NOTS and NOL's Advisory Board to set aside funds under the laboratories' control led to the introduction of another significant innovation: the "Foundational Research" fund.* Established by the Bureau of Ordnance for use at the laboratory director's discretion, the fund was designed to permit an uninterrupted program of "relevant" research, (i.e., which applied to new weapons, weapons trends, or the broad field of naval ordnance), in an environment of academic freedom and to foster work on the laboratory's specialty, which might be unrelated to its mission. The bureau established a separate allotment for Foundational Research and technical overhead. This was covered by applying a percentage markup to other projects, totalling a maximum of 20 percent of the laboratory's total annual project budget. Foundational Research was used as a tool to attract and retain creative scientists, to improve technical coupling with the academic world, and to support new and/or risky ideas.

* The term "foundational" was chosen to avoid confusion and conflicts with ONR's exclusive control over "basic" research.

In 1956, BuOrd's Assistant Chief (Research) allocated similar funds in other BuOrd R&D activities to the extent their capabilities warranted. In the late 1950's, other bureaus also attempted to introduce such discretionary funds; in response to pressures from the Office of the Secretary of Defense in 1964, it was applied to all laboratories as an "Independent Research" line item (see Chapter 8).

Bureau of Ships

The BuShips field activities were a heterogeneous group oriented toward hull-design, propulsion, and navigation, etc. One of the Navy's oldest and major RDT&E support activities was the David Taylor Model Basin. The activity incorporated two major facilities: the towing tank in which tests for surface ship and submarine hull shapes were conducted; and the Aerodynamics Laboratory, which included wind tunnels for aircraft model testing. Although part of a BuShips' activity, the Aerodynamics Laboratory was fully funded by BuAer.

Unlike the ship hulls, which were long-term items, major mechanical components for naval vessels were largely developed by industry. To support selection and procurement, activities such as the Boiler and Turbine Laboratory performed acceptance testing of prototype hardware, fuels, and lubricants. Other laboratories tested materials, processes, and auxiliary machinery; there was very little research conducted in BuShips activities, but following the dissolution of OSRD BuShips took over its Division 6 (ASW), functions.

In addition to the field activities providing support to BuShips Shipbuilding Division, several were sponsored by the Electronics Divison. The Naval Electronics Laboratory (NEL) at San Diego and the U.S. Navy Underwater Sound Laboratory (USNUSL) at New London were the principal in-house laboratories maintained for this mission. Work in these activities ranged from conceptual development in highly sensitive areas to technical monitoring and test and evaluation of prototypes.

In 1946, a Director of Research in the Shipbuilding Division had cognizance over the BuShips' field activities. After 1949, the Assistant Chief for R&D supervised the "health," funding and workload of the laboratories, and set policies for their general operation. When funding became tight during the 1950's, a Laboratory Management Office was established in an attempt to set overall bureau policies, balance workload between laboratories, and provide a central point of contact for both budgetary and technical phases of laboratory management. The Office imposed very tight controls over the activities, intensifying the bureau's tendency toward micromanagement (i.e., close oversight of R&D work details).

Within BuShips, R&D was organized on a project basis, and the in-house laboratories and/or industry were used to support the individual entities by means of specific task assignments on a given project. For each BuShips laboratory, the bureau set aside a block of money against which the various engineering desks "ordered" what they needed. The direct tasking and reporting system fostered close ties at relatively low working levels within the laboratories and the bureaus. It also eventually resulted in a proliferation of tasks and minimum flexibility at the laboratory level. The BuShips laboratories received instructions from the bureau "on a day-to-day basis, often to an astonishing degree of minutiae at the expense of scientific freedom, flexibility, and initiative."[14] Attempts, such as priority list systems, were tried unsuccessfully to ameliorate the situation.

Internal management and administration of the BuShips activities were handled by an officer designated "Commanding Officer and Director," who had overall responsibility for the laboratory. The senior technical civilian acted in the capacity of a staff advisor on the laboratory's programs. BuShips' project officers and civilian engineers generally retained direct management control over the work performed in the field activities.

Bureau of Aeronautics

A major influence on the entire BuAer field activity component was the existence of a vast civilian aeronautical complex. As a result, BuAer could and did rely heavily on industry to do its R&D work. At the same time, the unique feature of aviation, in which the crew rode the platform close in to the target, dictated a heavy commitment of BuAer R&D resources to flight safety. The character of the work conducted in BuAer activities was therefore consistent with both the nature and extent of the related civilian industry and the overriding man-machine relationship of aeronautical weapons systems.

Accordingly, BuAer activities were largely development shops concerned with demanding supervision over design and engineering, and test and validation of components and weapons systems generally developed and fabricated by industry. They seldom initiated the programs on which they worked. The Naval Air Test Station at Patuxent River, for example, carried out technical evaluation and acceptance trials of naval aircraft. The Naval Air Missile Test Center at Pt. Mugu fulfilled a similar function for BuAer guided missiles. While BuAer developed and flew some aircraft and missiles, e.g., at the Naval Aircraft Factory (Philadelphia) and the Naval Aircraft Modification Unit [(NAMU) Johnsville], it did not emphasize those functions; BuAer laboratory facilities were most often subordinate to engineering and test functions. In 1949, NAMU became the Naval Air Development Center (NADC).

The most frequent customers of BuAer field activities were elements of the bureau's component divisions, which tended toward excessive use of the "job shop" approach in task assignments, but which relied less on administrative controls than their counterparts in BuShips. At the same time, the "class desks" relied heavily on outside contractors for the most challenging work, due in part to the World War II pattern of utilization of industry for R&D assistance in a rapidly changing aeronautical environment.[15]

Emphasis in BuAer's activities on the later phases of RDT&E (and by definition, closer to the military operations end of the spectrum), was reflected in BuAer's imposition of exceptionally tight control over its activities. This tight supervision in the interest of flight safety was manifested by quasi-military internal organization and management of the activities, as well as by the work assignment patterns, discussed above. Emphasis on "man in the machine" concerns and, by extension, on flight safety and flight testing generated installation of unrestricted line aviators and Aeronautical Engineering Duty Officers (AEDOs) in most lines of the activities' operations. Because they served as the principal link between BuAer and the laboratory, their frequent rotation caused a degree of instability. They were also both highly technical and military, thereby representing a closed management organization which threatened to relegate the civilian scientists and engineers to an advisory capacity. At the same time, the rapidly advancing, technically riskier aeronautical program generated more technical dialogue and less micromanagement in BuAer compared to BuShips.[16]

Interlaboratory Relationships

Communication and cooperation between the laboratories often existed informally, although organizationally the laboratories were separated according to bureau, and theoretically official cooperation had to be accomplished through the chain of command. In addition, a certain competitive environment (often deliberately fostered by headquarters) inhibited close interlaboratory relationships.

In the early 1950's, Dr. Emanuel Piore, Chief Scientist, ONR, instituted the Senior Scientists Council. The Council met two or three times yearly and served as an informal gathering of civilian laboratory directors (in which the Secretary of the Navy also participated on rare occasions) for the purpose of exchanging views and information. According to some participants, the Council's civilian complexion caused the military commanders to look upon it with unassuaged suspicion, which was not entirely unjustified. In addition, emphasis on administrative problems rather than substantive program and management matters contributed to its eventual demise. Its potential effectiveness had also been undermined by formalizing its functions and increasing its size.[17]

POLICY ISSUES 1947-1958

Within the range of general policies and management procedures that evolved in ONR and the three bureaus, many variations developed. There were also aspects they all shared to one degree or another. Among these were several recurring issues and problems which are discussed briefly in the following sections to provide a framework within which the long series of laboratory studies (presented in subsequent sections) may be better understood.

Attracting and Retaining Scientific and Engineering Personnel

A perennial problem of attracting and retaining competent scientists and engineers in the military/civil service environment (involving its government regulations, salary restrictions, classifications, and hire/fire procedures) existed throughout the department, during the period. This was exacerbated by what some thought was a lack of "challenging" work in some military laboratories and the imposition of personnel ceilings which effectively governed the size of programs a laboratory could undertake.

The assumption by ONR and the bureaus of many of the National Defense Research Council and the Office of Scientific Research and Development projects and activities following World War II was motivated in part by the desire to tap the pool of scientific talent that had worked on military R&D during the war. Demobilization caused a certain outflow of trained military research personnel, nonetheless, and there was a lag in setting up appropriate civil service billets. To some extent, this prompted the continuation and expansion of the government-owned, contractor-operated (GOCO) concept which had been successfully used during the war.

The passage of Public Law 313 in 1947 (and subsequent amendments) authorized employment of an administratively limited number of positions outside the salary limits (and above the GS-15 level) of the civil service specifically to effectuate research and development functions relative to national defense. Initially, the Navy was permitted 15 of these high-level positions; this was reduced to 13 in 1948 to provide for such positions in OSD. Subsequent amendments increased the Navy's allotments.* Some alleviation of the need for more civilian technical personnel was provided by the Classification Act of

* Date of Amendment	P.L. 313's allotted to the Navy
July 1956	35
June 1958	86
September 1959	104
July 1960	118
August 1961	113
October 1961	154
1964	162

1949 which authorized "quota supergrade" positions. These could be applied to RDT&E positions, although it was not specifically stated. By 1955 the Navy had 40 supergrade positions of which an estimated 50 percent were involved in R&D.[18]

Rotation and Technical Training of Commanding Officers

Another problem related to the military complexion of the in-house laboratories was the rotation of laboratories' commanding officers. To some extent, rotation of line officers into RDT&E activities was considered desirable. First, it was necessitated by the career requirements of naval officers. Second, it brought in-fleet operating experience and understanding of new weapons and systems developments back to the laboratories. Nevertheless, some technical directors felt strongly that rotation compromised the stability and continuity of the technical program and inhibited the internal management and control of the activity. In addition, it militated against the continued development of a high level of competence in the officers who were technically oriented.

An important facet of the problem was whether or not the commanding officer of an RDT&E activity should necessarily have technical expertise. Questions were posed, for example, as to whether a technically trained officer would—and should—get more or less involved in the program itself; also, would his involvement, or lack thereof, be detrimental or advantageous to the programs. The underlying issue was that the military organization could potentially expand its control and impose on the technical aspects of research and development, decisions which might be both inappropriate and undesirable. Justification for such concerns seemed quite obvious in cases involving nontechnical military commanders. But ironically, the infusion of technically competent military officers into the laboratory framework often created its own conflicts arising from the potential of technical commanding officers to act as prosecutor and judge, expert and commander.[19]

In fact, neither naval officers nor civilian scientists thoroughly liked the system as it was. To many career-bound naval officers, assignment to a laboratory was viewed as the "kiss of death;" to many civilian scientists, a new commanding officer at the laboratory was potentially disruptive.[20]

Attempts to overcome some aspects of the problem included upgrading technical naval personnel and assigning trained line officers to RDT&E activities. In the postwar years, existing specialist corps* were expanded and postgraduate courses established, but the deep-seeded issues were not amenable to easy solutions: the military environment remained a fact of defense laboratory life, just as the civilian/technical element was

* Engineering Duty Officers (EDO), authorized by Congress in 1916; Aeronautical Engineering Duty Officers (AEDO); Ordnance Engineering Duty Officers (OEDO); and Construction Engineering Corps (CEC), descended from the original 19th century Engineering Corps.

inherent in research and development. Even after the extensive Riehlman Committee hearings and recommendations (1954) and subsequent studies on precisely this subject, the fundamental issue persisted to some extent throughout the era.

Military/Civilian Interrelationships

Forging a dynamic management team for conducting effective laboratory programs under these conditions and between individuals with inherently opposing philosophical views* was a challenge to those involved. In the final analysis, its success or failure was a question of degree and a function of specific project experience or personalities involved; it often worked very well.

The policies and traditions of the managing bureau or office were a strong influence on these interrelationships as was the civil service system. Several top-level R&D officials were quick to point out, however, that the tendency to blame most of the laboratories' problems on the limitations and restrictions of the civil service system was not entirely justified. There were, they point out, additional internal Navy Department regulations which "broke the back" of the laboratories, e.g., uniform, centralized, "bureaucratic" handling of all civil service billets without regard to the special character of R&D; and lack of classification and recruitment authority at the laboratory level.[21]

Still other members of the R&D community argued that the basic defense laboratory environment was better than depicted, proof of which lay in the subsequent necessity for commercial laboratories to raid defense scientific and engineering personnel to stockpile talent for missile development. A fairly average turnover in the in-house laboratory personnel also bore this out.**

Task Assignments

Another area of difficulty more or less common to the Navy's RDT&E activities related to program development and funding, the latter flowing directly from the former. Theoretically, there were two philosophical extremes within the bureaus for making project assignments to the laboratories. One extreme rested on the belief that laboratories were there to support the bureaus in their R&D missions, and therefore their work must be closely prescribed by the bureaus or the scientists would convert them into hobby shops. The other argued that the scientists could only work in an environment of unfettered freedom and should therefore be given money to conduct programs and then left alone.

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* See ASD(R&D) Donald A. Quarles and Dr. K.C. Black testimony during Riehlman Committee hearings.

** See testimony during Riechlman Hearings.

Although examples of the two extremes could be found in bureau/laboratory relationships, in actual practice the truth lay somewhere between the two extremes. (This point is further discussed in Chapter 15.) Much of the work conducted at Navy RDT&E activities after the war was self-generated (often by interaction between the laboratory and the bureau) and reflected what the technical director approved and in which the commanding officer concurred. Nevertheless, the issue of bureaus' utilization of the laboratories as "job shops" was frequently raised, albeit with full recognition that it was in some degree appropriate to ensure responsiveness to user needs.

From the laboratory point of view, the overriding concern in this issue was the implication of micromanagement on the part of the bureaus. In addition, it sometimes implied that less challenging work and headquarters' pet projects were imposed on in-house laboratories at the expense of outside, more desirable or more necessary work. This situation was further complicated by the need to support the existence of certain facilities with continuous funding and by the frequent correlation between "challenging" projects and high risk, which often precluded bureau approval of requested funds. The result was a tendency among the laboratories to "bootleg" money from some programs to do others they preferred.[22] The successful "Sidewinder" project developed at NOTS, China Lake, (partially funded with Foundational Research monies), was often cited as a prime example of this modus operandi.*

Mission Definition

A related problem was definition of the laboratories' specific missions. Technically, the laboratories were given responsibility for specific primary areas. This mission assignment ostensibly served to control the major thrust of laboratory programs and reduce duplication. It had the side effect of establishing the laboratory's "sphere of influence."

In reality, the laboratories operated under very broad mission statements and, especially in the immediate postwar years, often determined their mission post facto (i.e., according to the area in which they were doing the most work). This invited a tendency to "spread out," especially under one bureau. In some instances this caused overlapping and duplication, often a point of contention between higher level review authorities, interested in reducing costs, and technical people, who thought duplication desirable to obtain the best possible solution to a given problem. On the other hand, some laboratories deliberately sought to develop areas of special competence, while others were content to act as a "job shop" to maintain a secure level of work. The danger in the former approach was developing too exclusive a mission; the latter tendency led to

* Some branches of the bureau also helped, e.g., the Fuze Section funded infrared efforts.

mediocrity and lack of initiative. Although earlier attempts were made to revise some of the laboratories' missions, it was not until the late sixties, under the prodding of OSD, that a comprehensive effort was made to define more precisely the specific missions of every laboratory.

Facilities

The problem of acquiring adequate and modern buildings and facilities to improve the atmosphere of the defense laboratories as well as to have available the most up-to-date equipment was an issue that stemmed from the fact that RDT&E facilities were funded in the military construction appropriations, which were rarely adequate for all the demands on them. In competition with all the Navy's military construction (barracks, air-fields, piers, etc.), RDT&E requirements often fought a losing battle. A further complication was that decisions on military construction were made in the chain of command which were different from those made on program and personnel matters. RDT&E construction projects were actually incorporated into the District Commandants' area-wide program. The result was often that funds for R&D facilities lagged program decisions and needs. An attempt to rectify this problem in the mid-sixties by ensuring the representation of the newly created Director of Navy Laboratories at military construction meetings was largely unsuccessful.

STUDIES ADDRESSING RDT&E FIELD ACTIVITIES

For more than a decade after World War II, the roles, relationships, policies, and procedures affecting the Navy's RDT&E field activities remained relatively unchanged. Similarly, the issues surrounding laboratory management, the most significant of which were highlighted in the preceding sections, persisted. Symptomatic of their number, complexity, and endurance was the series of studies and reports addressing in-house defense laboratories which began in 1947 and continued to the end of the era and beyond. As the chairman of one such study observed, "probably no class of institution has been studied and analyzed, praised and criticized, organized and reorganized to the degree that has been the lot of the Defense laboratories."[23]

The following sections briefly describe and synthesize the main thrust of the studies that addressed defense laboratory issues between 1947 and 1958. The list of recommendations that issued from those studies (and later ones) is too long to enumerate within the scope of this Review. An ONR-sponsored compendium, completed in 1974,[24] reproduces those relevant to Navy research and development, the most significant of which are also highlighted below.

The Steelman Study 1947

The Steelman Study, conducted in 1947 by the President's Scientific Research Board, dealt with the broad question of the role of the Federal Government in organization and administration of the nation's postwar scientific effort. The problems and issues addressed ranged from the use of contractual devices to the need for in-house project/program planning systems. The Navy bureaus and offices submitted descriptions of representative scientific organizations. The Navy Department advised replicating the patterns found at working levels in the laboratories, which drew a fairly sharp distinction between research and development, to prevent short-range developmental objectives from crowding out research with less immediate application.[25]

Among the Steelman Study's broadly applicable conclusions and recommendations was that each Service develop long-range plans to consolidate research installations. In addition, emphasis on improving policies related to recruiting, classifying, stimulating, and compensating scientific personnel in government laboratories was an early preview of what was to become a perennial issue in subsequent laboratory studies. To this end, the Steelman Study made the specific recommendation that at the laboratory level of the National Military Establishment continued efforts should be made to place scientists in charge of the direction of the research program and commanding officers in charge of other management functions. The current trend toward establishing positions of research directors in naval laboratories and equivalent positions at the department level was praised and encouraged.[26]

The Riehlman Subcommittee Hearings and Report 1954

The first major assessment of military R&D, per se, was carried out at the legislative level with the 1954 hearings of Rep. R. Walter Riehlman's Military Operations Subcommittee. The Riehlman Committee focused on the problems of military/civilian relationships inherent in organization and administration of the military R&D program in DOD.* The inquiry centered around five questions; the major thrust was to determine what characteristics in the military environment were incompatible with research and development, and what, if anything, should be done about it.

Based on testimony and written responses from over 50 distinguished individuals of the scientific community, the Committee agreed that there were fundamental characteristics of a military organization that made administering an effective R&D program

* It had been initiated after several "acute" problems in the organization and the administration of the R&D programs were identified, e.g., during a previous inquiry into the guided missile program.

difficult. At the same time, neither the extreme "military control" position nor the extreme "civilian control" position offered a practicable solution. Correction of existing shortcomings in military R&D programs would depend on a "bold plan." In the short term, the Committee found the issue must be resolved through a much greater degree of participation and control by civilian scientists. At the least, the technical director should be used in an "optimum manner," and a uniform DOD policy should assign specific authority and responsibility to the civilian technical directors, spelling out unequivocally the relationships between him and the commanding officer. These recommendations were inspired by and referred to the example of the BuOrd laboratories described at length during the hearings.[27] Another major recommendation was for a full-time Assistant Secretary for R&D "to coordinate and dignify to the greatest extent possible the field of research and development."[28]

The Hoover Committee Reports 1955

The Second Hoover Commission task force on research and development reiterated the Riehlman Committee's concern over rapid rotation of military officers on R&D assignments and inadequate compensation for civilian scientists. It also concurred in the recommendation for a full-time Assistant Secretary for R&D.

While the previous studies dealt only generally with the question of utilization of in-house facilities vice contracting with outside performers, the Hoover Commission focused on this issue:

> In the Fiscal Year 1954, the Navy expended some 40 percent of its appropriated research and development dollar on work conducted within its own facilities. . .* The subcommittee believes that so high a level is questionable from the viewpoints of the most effective operation of the program and the most effective utilization of the research and development strength of the nation's academic and industrial organizations. The trend upward of the percentage of work within the Navy's establishments gives the subcommittee even more concern. The subcommittee recommends that the Navy Department make an objective appraisal of the division of effort between the installations of its technical services and those of the civilian economy. A transfer is indicated of some of the operations of applied research and development and design.[29]

* Data given to the Riehlman Committee (pp. 28, 75-6) based on FY53 expenditures indicated a split of 67%-33% (industry and in-house) for all DOD. Navy figures for the same year were as follows:
  - University and nonprofit (basic and applied research) - 10.4%
  - Industry (applied research and development) - 58.4%
  - Other government activities - 3.9%
  - Naval activities - 27.3%

The Committee commended the existing placement of basic research in the civilian economy and suggested "that it continue until there is a proven competence for basic research in the laboratories of the military departments." In its final Recommendation No. 14, the Commission stated: "Where a choice is possible, the operations of research and development should be performed at that place in the nation where they can be done most effectively and with the greatest efficiency." The implication was clear and, based on that criteria, the Committee estimated that some $125 to $150 million of the FY54 R&D program should have been done in the civilian economy. "Even where operations must be done in military installations, as in much of the tests for evaluation," the report noted, "increased effectiveness and efficiency will frequently be realized through contract operations by civilian economy organizations." In the interest of "good management" the Committee conceded that a shift of new programs to the civilian sector should be made in an evolutionary manner, with concurrent "shrinkage of staff" in the military installations.[30]

An assessment by one naval officer of the Hoover Commission's recommendation argued that the R&D results rather than economies were the goal and that civilian management did not guarantee results, especially where incentives associated with competition were removed. It was noted that the subcommittee that recommended increased contracting with the civilian economy included executives of large corporations and university administrators, and was therefore subject to a certain bias. At the same time, the broadest meaning of the phrase "civilian economy" implied both civilian pay scales and freedom from red tape, both of which were admittedly advantageous.[31]

Looking at other specific aspects of the Navy's R&D organization, the Hoover subcommittee recognized that some improvements were currently underway following the recommendations of the Gates Report (See Part I). It also commended the Navy for its success in building effective laboratories, e.g., NOL, NEL, NOTS; for its excellent training programs; its unusually large complement of senior technical officers; and the EDO program.

On the other hand, the subcommittee opined that even though the three laboratories mentioned were among the best of the military R&D centers, they were still not equivalent in effectiveness to comparable civilian laboratories. They also expressed deep concern over the need within the Navy to provide adequate programming and coordination of development programs, comprising some 85 percent of the R&D operations. Finally, the subcommittee noted that the "turnover" rate, i.e., rotation of R&D officer personnel did represent a handicap to both the development specialists' capabilities and the jobs themselves.[32]

Many of the problems and issues identified by the Hoover Commission were accepted as valid, but the reference to "shrinkage" of in house RDT&E facilities, especially in light of an expanding program (the Commission had also recommended increasing expenditures for research) was viewed with great concern. The Committee's statement that "in its present relative immaturity in military research and development, the military organizations cannot be completely relied upon for the initiation of such projects," prompted the following representative reaction of an officer associated with R&D (who had nevertheless endorsed several of the subcommittee's conclusions).

> Must we the scientist and the officer war against one another? Whereas, I agree in the results they wish to achieve and agree the system is inadequate, statements such as the foregoing tend to make one wish to oppose, not to cooperate.[33]

Over the short term, the Hoover Commission recommendations cited above had a demoralizing effect on the Navy's R&D community. Over the long term, however, their quantitative effects were minimal.

Report of the President's Science Advisory Committee 1958

Just 3 years after the Hoover Commission Report, the President's Science Advisory Committee (PSAC) published a small but influential report which went a long way toward reversing Hoover-inspired policy on utilization of the defense in-house laboratories. Underscoring the need to "strengthen Government programs in science and technology by promoting effective utilization of Government resources," the 1958 report emphasized that "undue reliance on outside laboratories in placing new work of large scientific interest and challenge could greatly impair the morale and vitality of needed Government laboratories. . ."[34] Among its recommendations were the now familiar incantations to improve civil service opportunities, salaries, etc.; to introduce funding stability into government laboratories; and to grant them more scope for doing basic research and negotiating contracts.

Like the earlier inquiries, studies, and recommendations, the PSAC report did not result in immediate or direct changes or improvements. The PSAC report was significant, however, as a signal that the shock of Sputnik had generated, at high policy levels, renewed emphasis on maintaining a viable military R&D capability. Nevertheless, it was only after the incoming administration took a look at recurring laboratory problems in light of the new imperatives, that visible changes in laboratory management and organization were initiated.

Notes to Chapter 7

1. SECNAV Instruction 3900.13, Subject: Management of the Navy Research and Development Laboratories, April 21, 1955; President's Scientific Research Board, (Dr. John R. Steelman, Chairman), *Departmental and Agency Statements on Research and Development Administration* (Washington, D.C., 1947), See Chapter VI, "Research Administration in the Navy Department."

2. Department of the Navy, *RDT&E Management Guide* (Washington, D.C., July 1, 1972), NAVSO P2457; Department of the Navy, *Review of Management of the Department of the Navy, Research and Development Management Study*, Vol. II Study 3 (Washington, D.C., October 19, 1962), NAVEXOS P-2426B-3, Section B, p. 3, (Hereinafter cited as *Dillon Board)*; Illinois Institue of Technology, *Technology in Retrospect and Critical Events in Science*, Vol. II (January 30, 1969); Personal Interviews.

3. Personal Interviews; Department of the Navy, *Review of Management of the Department of the Navy*, Vol. I (Washington, D.C., December 15, 1962) NAVEXOS P2426A, p. 179.

4. Personal Interview.

5. Personal Interview.

6. U.S., Congress, House of Representatives, Committee on Government Operations, *Organization and Administration of the Military Research and Development Programs, Hearings*, 83rd Cong., 2nd sess., 1954, pp. 88-97 (Hereinafter cited as *Riehlman Committee Hearings*).

7. Julius Furer, *Administration of the Navy Department in World War II* (Washington, D.C., 1959), pp. 753-754.

8. *Riehlman Committee Hearings*, pp. 86-87.

9. Secretary of the Navy, *Annual Report, 1946* (Washington, D.C. 1947), p. 71; Captain E.B. Hooper, "Draft to Form the Basis of a Possible Study on Navy Department Reorganization" (unpublished Ms, private notes to prepare for testimony before Franke Board), p. 3.

10. For a complete discussion of the military/civilian relationship at the special Devices Center, see the testimony of Bruce G. Eaton, Jr., *Riehlman Committee Hearings*, p. 119.

11. Personal Interview.

12. Naval Ordnance Laboratory Directive, Subject: Operating Principles, Naval Ordnance Laboratory (Approved by Rear Admiral M.F. Schoeffel, Chief, Bureau of Ordnance, December 28, 1951).

13. *Riehlman Committee Hearings*, p. 505.

14. Personal Interview.

15. Office of the Director of Defense Research and Engineering, "Report of the Task Group of Defense In-House Laboratories" (Washington, D.C., 1 July 1971) (Hereinafter cited as Glass Report); Personal Interview.

16. Personal Interviews.

17. Personal Interview.

18. "Historical Development of Navy Authorizations for Employment Above the GS-15 Level," Enclosure (2). (ONR Files.)

19. Personal Interview.

20. *Riehlman Committee Hearings*, Testimony of Dr. K.C. Black, p. 485.

21. Ibid.

22. Ibid.

23. Glass Report, p. 59.

24. Robert Mindak, *Management Studies and Their Effect on Navy R&D*, Office of Naval Research (Arlington, Va., 1 November 1974).

25. Dr. John Steelman, *Science and Public Policy*, cited in Robert J. Mindak, *Management Studies and Their Effect on Navy R&D*, Office of Naval Research (Arlington, Va., November 1, 1974), Section II, p. 7.

26. Ibid., Section II, p. 18.

27. *Riehlman Committee Hearings*, pp. 45-46.

28. U.S., Congress, House of Representatives, Committee on Government Operations, *Organization and Administration of the Military Research and Development Programs*, House Report No. 2618, 83rd Cong., 2nd sess., pp. 18-19.

29. Commission on the Organization of the Executive Branch of the Government, *Task Force Report on Research Activities*. Prepared for the Hoover Commission (Washington, D.C., 1955), pp. 59-60.

30. Ibid., pp. 81, 88.

31. Private notebooks of Admiral E.B. Hooper.

32. Commission on the Organization of the Executive Branch of the Government, *Research Activities*, pp. 47-48, 57-61.

33. Adm. Hooper notebooks, *op. cit.*

34. President's Science Advisory Committee, *Strengthening American Science*, (Washington, D.C., 1958), pp. 16, 20 (pamphlet).

CHAPTER 8

MAJOR CHANGES IN LABORATORY ROLES AND RELATIONSHIPS 1959-1973

The changes in R&D roles and relationships that occurred between 1958 and 1961 are discussed at length in Chapters 4 and 6. While their impact far transcended the Navy RDT&E field activities, they ultimately had a significant effect on the laboratories' management environment.

The establishment of the ASN(R&D), following the Franke Board report, provided for the first time a top-level civilian spokesman for the R&D community. His responsibility for broad policy matters and his role as RDT&E,N appropriations manager gave him considerable authority. The direct access to the ASN(R&D) enjoyed by the laboratories' technical directors on important issues provided them more leverage than they had previously exerted.

The merger of BuOrd and BuAer into BuWeps discussed in Part I also had an impact, at least on those activities directly involved. Spurred by subsequent policy directives of ASN(R&D) and DDR&E, the old BuAer laboratories experienced an ostensible evolution toward the management approaches of BuOrd. BuWeps also assumed contract management of laboratories, i.e., GOCOs, formerly used in BuOrd, but not BuAer, and there was a tendency in BuWeps toward less detailed engineering and management attention from headquarters. A centralized laboratory management office was set up in BuWeps to control manpower ceilings and appointments of military officers to the activities. Efforts to rationalize resource allocation, review overall laboratory programming, and coordinate workloads proved less successful.[1]

At the laboratory working level, things continued to operate pretty much as before, and many of the incipient problems of the fifties intensified or simply went unresolved. However, the technical directors had already begun to capitalize on the newly created focal points for R&D activity affairs to draw attention to the laboratory community's persistent problems and complaints. Ironically, as seen below, these new mentors were to some degree also part of the laboratory's growing problems: their sheer numbers and staff functions verified the extent to which the field activities had become submerged beneath increasing layers of bureaucracy.

EXAMINATION AND REEXAMINATION 1961-1963

By 1961, the restiveness in the defense in-house laboratories reached the attention of the new DDR&E and Secretary of Defense McNamara whose aggressive policies were often aimed at extending OSD authority and control throughout the RDT&E complex. Their initiatives activated a renewed round of studies, reviews, and recommendations for the improvement of the defense in-house laboratories. The ensuing, feverish activity and interest in the laboratories proved to be both a symptom and a result not only of unresolved issues but also of increased staff levels and review authorities in top-level defense R&D management echelons.

The following sections briefly describe the major efforts within the DOD to resolve those issues by imposing changes in the management and organization of the R&D activity complex; their eventual culmination in the promulgation of a comprehensive laboratory reorganization plan; the Navy Department's response and eventual implementation of major organizational changes; and latter-day attempts to resolve laboratory problems still outstanding at the end of the era.

Task Force 97

When Robert McNamara assumed the Office of Secretary of Defense, he formulated 120 questions, the answers to which were to provide policy direction for his administration. Number 97 was "What must be done in order to enhance the capability of our in-house research and development laboratories?"* Behind the question was the new administration's "concern that our ability to contract for a multibillion dollar research and development program with industry and the not-for-profits, including the universities, required a degree of sophistication that was not readily apparent in our laboratories."[2]

As a first step toward answering the question, Task Force 97 was organized under Chairman Dr. Eugene Fubini (Deputy DDR&E) and Executive Director, Dr. John Golden (Weapons Systems Evaluation Group). The group reviewed R&D laboratory studies and reports extant and visited a number of defense laboratories. At the end of a preliminary phase, the group reported to the new DDR&E, Dr. Harold Brown, five major problem areas associated with (1) the mission of defense laboratories, (2) problems of organization, personnel, and salary, (3) fiscal and budget problems, (4) construction to support RDT&E and, (5) morale.[3]

* This "question" has also been quoted as "Advise me ways in which to improve the operations of the in-house laboratories."

Announcing Task Force 97's preliminary findings, Dr. Brown noted that the dividing line between in-house and contract research had not been clearly drawn in the past, and that there were four major reasons for performing RDT&E in the defense laboratories. These reasons are as follows:

- To form a spearhead to investigate rapidly changing technologies for their relevancy to military problems and, simultaneously, to bring military problems to the attention of the general scientific and technical community
- To provide objective scientific and engineering advice on contract R&D programs
- To manage or help manage weapons systems development and test programs
- To develop cadres of technically proficient military officers to operate the modern armed forces.

Taking up the five major problems that Task Force 97 had identified, Dr. Brown highlighted what he viewed as contributing factors to those problems:

> Many R&D Laboratories are too far down in military organization from the top R&D authorities. The organization for management of RDT&E in the Defense Department can be simplified and a trend in which rank has tended to become identified with review rather than management must be reversed. . . It is clear that one of the most effective ways to remove layers of management has been to appoint a civilian or military project director of sufficient talent, authority and rank that only persons of like talent or rank may presume to police his efforts...The matter of acquiring and retaining leading scientists and engineers has become of paramount importance. . .[4]

Among past policies that were seen to have inhibited this latter requirement were (1) low salary scales, (2) undue layers of intervening managers and reviewers, (3) the working environment, including attitudes of management toward research (e.g., "does it understand the difference between a research and development program and a scientific job-shop?"), and (4) the physical environment (i.e., the quality of facilities).

Admitting that "too many high-level review teams have reported similar problems over too long a period of time, and that the rate of progress in providing relief has been too slow," Brown stated decisively that "action must be taken, and quickly."[5]

McNamara's October Memorandum

Brown's call to action and Secretary McNamara's endorsement of the preliminary findings of Task 97 were reflected in McNamara's memorandum of October 14, 1961, circulated to the Service Secretaries. It was a major milestone in the resurgence of emphasis on utilizing defense in-house laboratories and set the tone of future top-level defense policies, whose avowed purpose was to maintain a "vigorous program and the highest morale" as well as to raise and maintain "technical standards...at the highest level" within the defense laboratories. Accordingly, McNamara stated in his memorandum that he had instructed the DDR&E "to formulate and carry out a program of strengthening the in-house laboratories," according to five fundamental principles:

- They were to be used as a primary means of carrying out DOD programs.
- Clear lines of technical management and responsibility within the laboratories, as well as procedures by which principal laboratories of each Service would be brought under the more effective control of the assistant secretaries for R&D, were to be established.
- A fraction of the annual laboratory budget was to be set aside for work at the director's discretion. (This was already being done in several Navy laboratories, as discussed elsewhere in this Part.)
- Personnel policies and compensation rates were to be improved, taking full advantage of the PL-313 provisions.
- Appropriate salaries would be provided for senior personnel.[6]

The decision to strengthen the in-house laboratories, which was made at the highest defense policy level, was closely followed and reinforced by the Bell Committee, which had recently been convened to study government contracting for R&D.

The Bell Committee Report

The Bell Committee was an interdepartmental task force set up by the Bureau of the Budget. It worked with the Civil Service Commission and DOD to study government contracting for R&D. Submitted to the President in April 1962, the Bell Committee Report strongly reemphasized the need to maintain in-house laboratories to make sound technical decisions and enhance the government's competence as a sophisticated buyer. While it also concluded that the government should continue to "rely heavily" on R&D contracts with nonfederal institutions, it recommended improvements in contracting

systems and retention of management and control in the hands of government technical specialists. To this end, the Bell Committee concurred with Task 97 regarding improvements in the government's research and development establishments by ameliorating the working environment in order to attract and retain first-class scientists and technicians. Ironically, the Committee recognized that the deteriorating environment in the government laboratories was due primarily to increased reliance on outside contractors. . . which the Committee also endorsed! "There is no doubt," said the Report, "that the effects of the substantial increase in contracting out federal research and development work on the government's own ability to execute research and development work have been deleterious."[7]

The Bell Report emphasized the need for effecting the following major improvements in the laboratories:

- Assignment of significant and challenging work in the form of major items vice narrowly specified tasks
- Simplification of management controls, elimination of unnecessary echelons of review and supervision, and assignment to laboratory directors of more authority to command resources (including a discretionary allotment of funds, for which he alone is responsible) and to make administrative decisions
- Elevation of salaries, particularly in the higher grades, to provide greater comparability with private industry
- Amelioration of military/civilian relationships in the laboratories, including clear delineation of operational and technical functions and predomination of military or civilian, where appropriate.[8] (This had already been accomplished in some BuOrd laboratories.)

Task 97 Action Group

Following up on the preliminary report of the Task 97 study group, now reinforced by the recommendations of the Bell Committee report, McNamara and Brown reinstituted the team as the Task 97 Action Group on March 30, 1963. Willis B. Foster was named Executive Director. Made up of joint Civil Service Commission and Department of Defense teams, Task 97 established a core of permanent members* responsible for its

* The Navy was represented by Dr. J.N. Adkins (ONR) and by Dr. H.J. White [Office of ASN(R&D)], later replaced by Dr. W.P. Raney.

continuing operation. The Group called upon problem-area specialists in DOD and representatives of different levels of management within the department to review and follow up on problems uncovered during visits to nine defense laboratories. The assignment was carried out in three phases, each dealing with a major problem area: Phase I - Manpower and Personnel; Phase II - Budgeting, Accounting, and Programming; Phase III - Military Construction and Supporting Services.

The Navy Department "cooperated" with these Task 97 study teams, although reports from the laboratory management back to the bureaus indicated some ambiguity about the teams' ultimate ability to effect meaningful changes.* "In general," wrote one officer, "the laboratory staff found the Task Force 97 Group interesting; whether or not it was significantly productive to them or to us we could not tell." And another noted, "I hope we have generated no new problems as a result of their visits."[9]

Astin and Furnas Reports

In addition to the Task 97 activities and the Bell Report, two other high-level studies of the early 1960's deserve mention, if only to illustrate the intensity with which the defense in-house laboratories were being reviewed, studied, visited, and advised. In 1960, a standing committee of the Federal Council for Science and Technology, chaired by Dr. Allen Astin, Director of the Bureau of Standards, was formed. The major thrust of the committee's two-volume report, entitled *Competition for Quality* (1962), was an examination of the salary and nonsalary factors that affected the government's ability to compete for scientists and technicians.

Also in 1962, a subcommittee of the Defense Science Board was formed under Dr. Clifford Furnas at the request of the DDR&E. The Furnas Committee reviewed the Astin and Bell Reports. Pointing to the latter's belief that the government must provide effective technical supervision, the Committee warned against too rigid performance of this role in telling contractors exactly what to do: "This may be appropriate for straight production contracts, but if such a system should come to dominate research and development, many of the nation's most vital sources of creativity and scientific ability would be barred from making essential contributions to necessary DOD research and development programs."[10] Otherwise, the Furnas report concurred with the recommendations of the Bell Committee regarding the improvement of the in-house laboratories and then made several additional recommendations (concerned largely with salaries, leave, and recognition of scientists) in order to "reverse the present trend toward weakness."

* For an amusing account of how the visits looked from the Task 97 point of view, see Willis Foster's speech at The American University, April 1963.

The Dillon Board 1962

Within the context of a comprehensive review of the Navy Department's organization conducted by the Dillon Board, the Navy RDT&E field activities were evaluated by the Research and Development Management Study Group, directed by Rear Admiral Rawson Bennett, USN(Ret.). Its major conclusions focused on personnel problems, lack of clear guidance from above (compounded by an inverted management pyramid with laboratories at the bottom), lack of a long-range Navy plan, the need for unfettered funds for the laboratories, perennial cognizance problems, work assignments, and unresolved issues raised by the "lead laboratory" concept. The last of these referred to attempts since the late fifties to assign primary responsibility for specific areas of science and technology to several laboratories by instruction, on the basis of either cognizance or competence. The question of reassignment of work, based on an idea originating outside a laboratory's assignment, was one of the sensitive problem areas now surfacing.[11]

Among the total 524 recommendations made by the Dillon Board on all aspects of the department's operations and management, those which pertained directly to the in-house laboratories generally advocated developing procedures to conform with current defense policies (i.e., as enunciated by McNamara and Brown) and with the Bell Committee recommendations. The Dillon Board also recommended adequate means for the ASN(R&D) to exercise control over all R&D, regardless of funding source, consistency among the bureaus "so that all laboratories may operate within common guidance," joint consultation with laboratory management regarding relevant internal procedures and practices, expedition of laboratory research proposals to the bureaus, and RDT&E funding flexibility, in general.[12]

NAVY DEPARTMENT RESPONSES

The Navy Department reacted to this plethora of studies and recommendations with a number of responsive actions. E. M. Glass, who served as Executive Director of Task 97 Action Group after Dr. Foster, remarked that the Navy, in particular, took OSD's efforts quite seriously.[13]

In 1965, Rear Admiral E. A. Ruckner, DCNM(Dev) reviewed and analyzed all 42 pertinent recommendations contained in McNamara's memorandum, the Bell Report, and the Dillon Report. He calculated that 26 had been fully implemented, 12 partially implemented, and 4 not at all.[14] In support of these statistics, Admiral Ruckner cited several examples, noting also that in some instances the Navy had taken initiatives to correct certain problems prior to the recent studies.

Laboratory Funding

An example of early Navy attempts to improve laboratory funding procedures was the initiation of "Foundational Research," a discretionary fund allocated to the Bureau of Ordnance laboratory directors long before the McNamara memorandum (see Chapter 7). In response to Secretary McNamara's policy statements, the Dillon Board, et al., the Navy introduced into all laboratories both Foundational Research* and Independent Exploratory Development (IED). IED was a second discretionary fund allotted to laboratory technical directors for exploratory development programs. (For further discussion of IR, IED, and latter-day Direct Laboratory Funding, see Chapter 17.)

Military/Civilian Relationships

The Navy response to the delicate issue of military/civilian relationships** in the laboratories and the current emphasis on delineation of their respective roles was SECNAV Instruction 3900.13A of November 1, 1963. This was also an expansion of existing policy. Making reference to Secretary McNamara's memorandum, the Dillon Board Report, and the Bell Committee Report, the Instruction established specific policies and procedures for management and operation of Navy R&D laboratories. Recognizing the relatively stable and successful internal management relationships in the Bureau of Ordnance laboratories, described and praised during the Riehlman Committee hearings almost a decade earlier, the Instruction was largely based on their "operating principles." The significant feature of the Instruction was its endorsement of the dominant role of the technical director in the performance area, while reaffirming the overall management responsibility of the military commander. The key paragraph provided that "the Commanding Officer will delegate line authority and assign responsibility to the Technical Director for the technical program, its planning, conduct, and staffing."[15] Other significant provisions in the Instruction endorsed definition of laboratory missions that would "identify those principal objective areas within which the laboratory is expected to lead and excel and concentrate its capabilities." It stated that in developing the RDT&E program, "prime consideration will be given to the naval laboratories for the purpose of assuring them interesting and challenging assignments," and affirmed the designation of Independent Research and Exploratory Development funds for all R&D laboratories. To minimize personnel problems at the top level of the laboratories' internal management, the ASN(R&D) assumed responsibility for approving appointments of all commanding officers and technical directors.

Within the R&D community, not everyone approved this new policy statement. Most military commanders accepted it, although some felt it raised an issue for

* Foundational Research was renamed Independent Research (IR) in 1964 and established as a budget line item.

** Military/civilian relationships, described in Chapter 7, continued more or less unchanged in the sixties.

technically competent military commanders who believed they could not properly command without a voice in the direction of the technical program. One top-level officer characterized the instruction as a "gross error, a procrustean approach to what was both impossible and undesirable," i.e., attempting to define precisely the relationship between the commanding officer and the technical director that always depended, in the final analysis, on the personalities involved. To another top officer, the Instruction was representative of the steadily increasing postwar confusion that led to focusing on matters other than primary objectives. In a few instances, the Instruction was ignored to the degree that it was not even distributed to the bureau's laboratories.[16]

Civilian Personnel Matters

Another step taken within the Navy organization in response to the laboratory studies was the formation of a special study group consisting of personnel from the Navy Department's Office of Industrial Relations (OIR) and two boards of civil service examiners. This group visited 28 R&D activities and identified 50 specific problems within the Navy organization. A number of solutions were offered, but the results were not clear. Some headquarters officials were, in any case, skeptical about the involvement of the OIR in laboratory matters.[17]

In the meantime, the legislative branch had made an attempt to improve the lot of civilian personnel in the defense RDT&E laboratories. The Salary Reform Act of 1962 authorized allocation of civil service grades 16, 17, and 18 to professional positions primarily concerned with RDT&E. Unlike previous legislation, this authority contained no numerical limitations, so that RDT&E positions formerly in the "quota supergrade" pool could now be established at higher levels as "nonquota supergrades" in addition to PL 313 positions. Exhibit II-2 below shows the nonquota RDT&E supergrade positions established in the Navy Department between 1963 and 1973. These can be compared against the following distribution of supergrade positions in the Navy's R&D organization in 1953-1954: GS-16 (19); GS-17 (2); GS-18 (0).

Finally, the Chief of Naval Operations took an initiative toward recognizing the need to make adjustments in the RDT&E field activities. In a memorandum to all district commandants, the CNO directed that: "Prompt effective action will be taken in those areas coming under the responsibility of the Commandants which will improve morale and assist personnel retention."[18]

EXHIBIT II-2
Nonquota RDT&E Supergrade Positions
in the Navy Department
in Addition to PL 313's *1963-1973

31 December	GS-16	GS-17	GS-18
1963	158	0	0
1964	177	0	0
1965	174	3	1
1966	194	4	2
1967	224	8	2
1968	244	10	2
1969	258	10	2
1970	249	14	2
1971	**	**	**
1972	**	**	**
1973	~220	**	**

*See Chapter 7 for PL 313's
**Not Available
Source: ONR files.

THE SHERWIN PLAN AND ITS AFTERMATH 1964-1966

About one year after the Task 97 Action Group was initiated, officials in the Office of DDR&E began to look for another approach to handling laboratory problems. One of the group members, E.M. Glass, later wrote:

> A consensus developed to the effect that the in-house laboratories lacked meaningful problems, management stability and prominence, and recognition and that they failed to impact at the highest policy levels. While administrative improvements were valuable and should be diligently sought, they were not considered, in themselves, sufficient to make laboratories effective tools of the organizations they serve. . . In the latter part of 1965 (sic), there evolved a new concept designed to produce fundamental changes in the DOD in-house laboratories, of which the following were salient features:
>
> (1) The proposed reorientation of the larger Defense laboratories toward military problem areas or military missions...

(2) The proposed elimination of echelons between the military departments' Assistant Secretaries (R&D) and the principal mission-oriented laboratories through the establishment of a new technical line management structure headed by a Director of Laboratories with requisite authority to provide the proper environment for Departmental R&D.

(3) A proposal that the laboratories encompass the full spectrum of R&D (from research through operational systems development) with respect to a military problem area... The Secretary of Defense forwarded this plan to the Military departments for the implementation of some such plan in each of the military departments.[19]

The Sherwin Plan

The plan to which Glass referred was entitled "A Plan for the Operation and Management of the Principal DOD In-House Laboratories." Known as the Sherwin Plan, it was conceived and formulated at the end of 1964 by the then Deputy DDR&E, Dr. Chalmers Sherwin, who interpreted the main thrust of his position as a mandate to "upgrade the DOD R&D capability via central control in DDR&E."[20] Inspired largely as a follow-on to the Bell Report and a response to continued laboratory complaints about restrictive policies and unresolved problems,* Sherwin proposed a sweeping reorganization. Its stated objectives were to raise substantially the prestige of the laboratories, increase their quality, simplify their management, and improve career patterns for technical civilians. The plan's key management concept, said to be inspired by industry examples such as Bell Labs, was that "in order to maintain a high quality research and development operation, appropriate organizational barriers must exist between the various stages of the total process." This implied institutional separation between the initial R&D functions of research, exploratory development, and advanced development, on the one hand, and the functions of engineering design, production, and operations, on the other hand.[21] A further fundamental assumption on which the plan rested was that "maximum effectiveness of a mission-oriented R&D laboratory occurs when its financial support is approximately equally divided between self-generated programs and programs responsive to user demands." This concept was influenced by the operations of the triservice laboratories, e.g., Monmouth, which conducted a lot of self-generated work.[22]

*Several individuals, e.g., E.M. Glass and E. Reilly were also cited as strong influences on Sherwin to propose the reorganization (Interview).

Implementation of these principles was admittedly difficult, he noted, due to: (1) the "unprecedented size" of DOD in which "almost all of the DOD laboratories. . . find themselves struggling under a staggering load of red tape and diffused, nonexpert supervision," (2) the unique military function, and (3) the unusually large engineering design and procurement function of the department. The principal means for implementing his key management policies and objectives within the DOD context was presented by Sherwin in a comprehensive plan, the organizational concept of which is reproduced in Exhibit II-3. Following is a synthesis of the major elements of the plan that would:

- Raise the level at which and to which the laboratories report and shorten the chain of management.

- Create vertical departmental laboratory organizations, "managed by scientists and engineers in a continuous line up into the policy level of the Department." Technical officers would also be included in line management positions. The laboratory organization would actually be one of three vertical organizations, the other two encompassing military operations, and weapon systems development and procurement.

- Create a Director of Laboratories responsible for the operation of all supporting functions in the laboratory system uniquely requiring military management and reporting directly to the ASN(R&D).

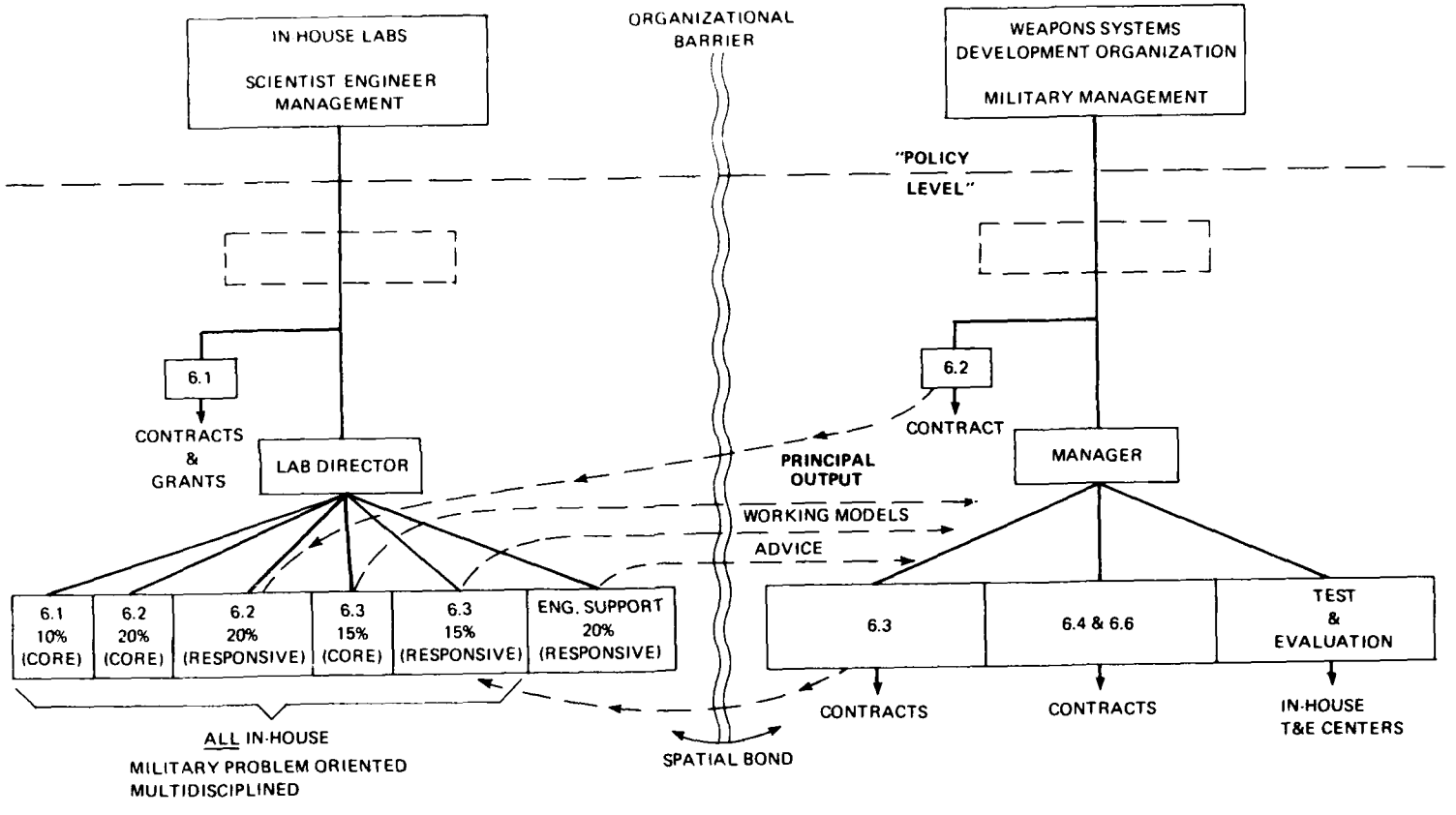
- Group the laboratories into functional centers composed of principal laboratories with broad military problem-oriented missions and satellite laboratories reporting to the center.

- Place each laboratory under line control of a professional scientist or engineer reporting to "an appropriate policy-making level in the department," e.g., the Assistant Secretary for R&D, with no more than one manager between the laboratory director and the policy level.

- Perform work within each laboratory covering "the full and balanced spectrum of research, applied research, actual systems design and construction, combined with participation in the management of the engineering design of systems scheduled for deployment." Distribution of effort should be roughly equal between R&D and systems-oriented programs, and also roughly equal between an established "core" program, independent of systems managers and a "responsive" program dependent on the systems managers.

- Create an appropriate organization barrier within each laboratory between the technical disciplines and between research and development.[23]

EXHIBIT II-3
Organizational Concept of the Sherwin Plan



SOURCE: "A PLAN FOR THE OPERATION AND MANAGEMENT OF THE PRINCIPAL DOD IN-HOUSE LABORATORIES," (SHERWIN PLAN) 16 NOVEMBER 1964.

An example of how the new concept could be applied in the Navy was also drafted and attached to the Sherwin Plan for circulation to the Services. Entitled "A Proposed Plan for the Organization of the Principal Navy In-House Laboratories." dated November 16, 1964, it outlined a consolidation of 13 laboratories into nine principal laboratories, responsible to a Director of Naval Laboratories (DNL), who reported in the line to ASN(R&D). In addition, the Navy example provided that the DNL "have authority over the allocation of not only the core program funds, but also manpower, facilities, and supporting funds required to carry out this RDT&E mission."[24]

The Sherwin Plan and the Navy "example" were transmitted on November 20, 1964, by Secretary McNamara (via DDR&E) to the Secretaries of the military departments with a request that they join the DDR&E in "working out the detailed implementation of some such plan in each of the Military Departments."[25] Upon receipt of the proposal, Dr. Morse, the current ASN(R&D), and his respective colleagues in the other two Services approached Deputy Secretary of Defense Vance to voice unanimous and firm objection to the Secretary of Defense "telling the Services how to run their organizations."[26] Secretary of the Navy Paul Nitze also personally complained to Secretary McNamara that the "Navy plan" went too far in telling the department not only what to do but how to do it. Five days later, Dr. Brown circulated a clarification:

> It must be clearly understood that the referenced [plan] is to be considered as only one example of a solution. By using such an example, I hope I have conveyed in a concrete form. . . the problems which appear to me to exist. . . It is clear that the different Departments and particular activities in them, have different character, mission and history. Therefore I am fully aware that there can be no standardized solution. No intention to impose a single solution in implementing some such plan for laboratory organization should be inferred. . . On the other hand I must remind you that problems of this kind have been discussed for many years by many committees, in each Department, in OSD, and even on higher levels, and that conclusions reached during these discussions have never seen a large scale implementation. . . the time has come to find solutions of more general scope and application. This will require that levels of management which heretofore have given the problem only attention and concern, must now take action.[27]

Navy Department Response

While the specifics of Sherwin's proposal were therefore not imposed on the Services, OSD had now made it clear that the Services must effect changes in the laboratory

organization. Dr. Morse, for one, felt uncomfortably on the defensive vis-a-vis OSD. After designating five task groups to examine the major issues involved, and discussing the resulting studies with the Navy's three most senior military R&D officials [CNR, CND, and DCNO(Dev)], he submitted, on January 4, 1965, a proposed plan for management of Navy laboratories. The plan (reproduced in Appendix A) was forwarded by Navy Secretary Paul Nitze to Secretary McNamara on January 8, 1965.

The most significant step proposed by Dr. Morse was the establishment of a civilian Director of Navy Laboratories (DNL), reporting to ASN(R&D) and "co-equal" with the CNR and the CND. The DNL was responsible not only for uniform implementation of laboratory policy matters, but also for many specific questions related to the selection of key civilian personnel, and long-range planning for activities and facilities development. In short, his office was to provide high-level departmental attention to the laboratories.[28] In addition, Dr. Morse pledged to initiate " 'block' funding (See Part V) of sufficient magnitude to provide laboratories with both improved funding flexibility and greater independently planned exploratory development effort." Finally, he undertook to "examine" present policies and practices concerning military construction, maintenance, personnel, financial management, and the weapons systems involvements of the laboratories and "take steps" to alter them in view of the OSD objectives.[29]

While reacting directly to the OSD plan by establishing the Office of the DNL, albeit reluctantly,[30] the ASN(R&D) strongly emphasized the Navy's refusal to go along with other proposals, particularly the "organizational barrier" within the laboratories and the organizational separation of the principal laboratories from the bureaus. With regard to the latter, Dr. Morse explained the Navy position:

> This move in the long run could only isolate the laboratories from the mainstream of R&D decisions, and make them less effective in support of the total technical effort. Laboratories, to be effective, must be centrally placed in the Navy; yet, laboratories, to be good, must be given special management attention.
>
> The OSD proposal achieves the required management attention by separating laboratories in essential ways from the rest of the Navy. Even if I thought this would make dramatic and immediate improvements in the internal health of the laboratories (which I do not), the price in effectiveness would be too great. . .[31]

Morse also rejected the concept that the principal laboratories be managed exclusively in a civilian chain, while the bureaus' R&D functions were managed by military officers. "Not only would there be an organizational barrier through the center of the development organization, but this would be a civilian-military cleavage as well." The results with respect to the Navy, said Morse, would be "unfortunate."[32]

The Navy response, therefore, took into account the need for "significant steps to improve the effectiveness of the laboratories," but rejected major elements of OSD's organizational solutions as fundamentally incorrect for the Navy. Its plan focused instead on increasing the technical competence of the laboratories and giving them "an increasingly responsible role in weapons systems decisions, planning, and followthrough."[33]

REALIGNMENT OF RESPONSIBILITIES AND AUTHORITY 1965-1966

The major element of the Navy Plan, i.e., establishment of a Director of Navy Laboratories, was implemented on December 20, 1965. As indicated in Chapter 6, the DNL was originally conceived as a staff policy advisor to ASN(R&D), responsible for setting policies for management of Navy R&D laboratories. In his charter, DNL carried a "double-hat" as Director of Laboratory Programs (DLP) reporting to the DCNM(Dev) in the Office of Naval Material.[34] Inconsistencies and conflicts raised by some of the charter's terms (discussed below) fueled considerable subsequent criticism, which continued to the end of the era, and included charges that the DNL/DLP office "did not and could not work."

Implementation of the Office of the Director of Navy Laboratories (DNL)

Prominent among the provisions of DNL's charter was the control and guidance of the in-house Exploratory Development technical program and the application of programmed funds. This directly conflicted with both the responsibilities of CND, whose charter also gave him responsibility for Exploratory Development, and the material bureaus, which retained effective control over the bulk of laboratory funds: on the other hand, neither objected to DNL's assignment of responsibility for guiding the in-house laboratory Independent Research (IR) and Independent Exploratory Development (IED) programs. (They represented a considerably smaller percentage of R&D funds.)

A significant and very basic problem issuing from the DNL/DLP charter was the questionable organizational concept inherent in the double-hatted positions. The charter provided both positions with precisely parallel duties and responsibilities, although one functioned as staff to the ASN(R&D), the other in a delegated line position under the CNM. The lack of any clear delineation in the positions, as well as the discrepancy in reporting levels [DNL reported directly to the Assistant Secretary; DLP reported to CNM via DCNM(Dev)], had several deleterious effects. First, it virtually ensured exclusive use of the DNL title by the incumbents, which tended not only to subvert the intended accountability of the DLP to DCNM(Dev), but also to undermine Dr. Morse's stated reason for creating the DLP hat, i.e., to ensure the office some strength through the CNM organization.[35] Equally serious were the instability and conflict of interest stemming

from the requirement imposed by the dual reporting roles to achieve policy agreement between the ASN(R&D) and the CNM. Both a reflection and a symptom of this problem was the fact that neither the CNM or the ASN(R&D) ever strongly supported DNL/DLP's charter roles.

The friction and confusion at headquarters level was duplicated in relationships between the DNL/DLP and the laboratories. If the DNL/DLP power and responsibilities at headquarters were unclear in the charter, so too was his relationship with the laboratories. To the degree that the DNL's effectiveness as a focus of special management attention for the laboratories depended on control over the laboratory resources (and it did), he was virtually powerless. For example, the first DNL's attempt to assign lead laboratory responsibility, and along with it, all of the funding for projects within its assignment, foundered on the SYSCOMS' refusal to go along and the DNL's inability to enforce his decisions. The policy of the next DNL to withhold a portion of IR/IED funds as a "reservoir" for "good" ideas served only to annoy the laboratories and encourage them to adopt "salesmanship" techniques as a means of promoting their projects.[36]

Furthermore, the designation "Director of Laboratory Programs" was in itself a misnomer, since the DLP literally had no program responsibilities (nor did the DNL). In short, the line of demarcation between the DNL/DLP and those with program responsibility involving the laboratories was never clear. In the wake of the subsequent transfer of the laboratories from their parent bureaus to the CNM in 1966 (see below), the failure of the DLP to materialize as a strong management entity contributed to the laboratory directors' frustration and confusion over lines of reporting and authority. At the working levels, laboratory personnel "rode out the storm" by returning to the program personnel with whom they had always dealt.

The inherent weaknesses in the DNL/DLP position, lacking both clear-cut control over the laboratories' funds and adequate staff assistance, were recognized immediately at its inception by a top candidate for the job. He declined the position. The first DNL tackled the problem of defining his authority by attempting to control in-house Exploratory Development money; he succeeded only in antagonizing both the CNM staff and the systems commands. In the case of at least one SYSCOM, resentment led to an attempt to circumvent the DNL by funding R&D projects in its engineering stations (i.e., outside the purview of the DNL).[37]

The second DNL "decided it wasn't worth the fight," and confined his control to the IR/IED discretionary funds. By his own assessment, this provided him a "management evaluation tool," in terms of indicating wherein the laboratories' interests and talents lay, as well as a means of supporting future-oriented efforts, i.e., counter-to-current "trends."[38] Furthermore, while the discretionary funds represented only a small proportion of total RDT&E funds, their importance to the laboratories as "their" money, provided the DNL considerable leverage.

Ultimately, the second incumbent defined his role principally as a laboratory ombudsman in Washington with a two-pronged objective:: (1) "to make the laboratories stop feeling like second-class citizens," and (2) "to mold them into one community."[39] Even with this modified interpretation of the office's functions, however, he was frustrated by both the systems commands (which continued to "job shop" the in-house laboratories and rely on outside contractors for major projects) and the laboratories (which returned to their traditional modus operandi both in terms of their relationship with the systems commands and their program orientation).

Almost from its inception, attempts were made from many quarters to revise, replace, or even eliminate the office of DNL/DLP. Through the end of the era, however, no revisions were made in spite of observations such as the following:

> The DNL function was originally faced with widespread opposition. Much of this opposition has now [1969] subsided, more from a growing realization that his charter wasn't going to be implemented than from the "healing balm of time." A simple reshuffle will not be sufficient to make the charter a viable document.[40]

RDT&E Laboratories Transferred to CNM

Effective April 1, 1966, both command and management control of the RDT&E laboratories were transferred to the Chief of Naval Material. There were several factors underlying this major organizational and management change. First, was the prevailing OSD policy to raise the laboratories' status and broaden their missions. Second, was the argument that replacing three different management systems and decisionmaking apparatuses would eliminate duplication and accounting confusion and permit better coordination. The change was also aimed at making the laboratories' technical expertise available on a corporate basis.[41] Finally, the implementing memorandum of March 18, 1966 established a rationale related to the recently created civilian office of DNL/DLP:

> In his capacity as Director of Laboratory Programs (DLP) under the CNM, the DNL is charged . . . with the performance of certain specific functions which might at times appear to infringe upon the military command authority if such authority were delegated to an echelon below that of the Chief of Naval Material. In order, therefore, to preserve the Navy command line to the R&D establishment and ensure that there is no impairment of the responsiveness on the part of the Laboratories to the military requirements of the operating forces, it has been decided to place direct military command

at the same echelon as that at which the authority of the civilian Director of Laboratory Programs is exercised.[42]

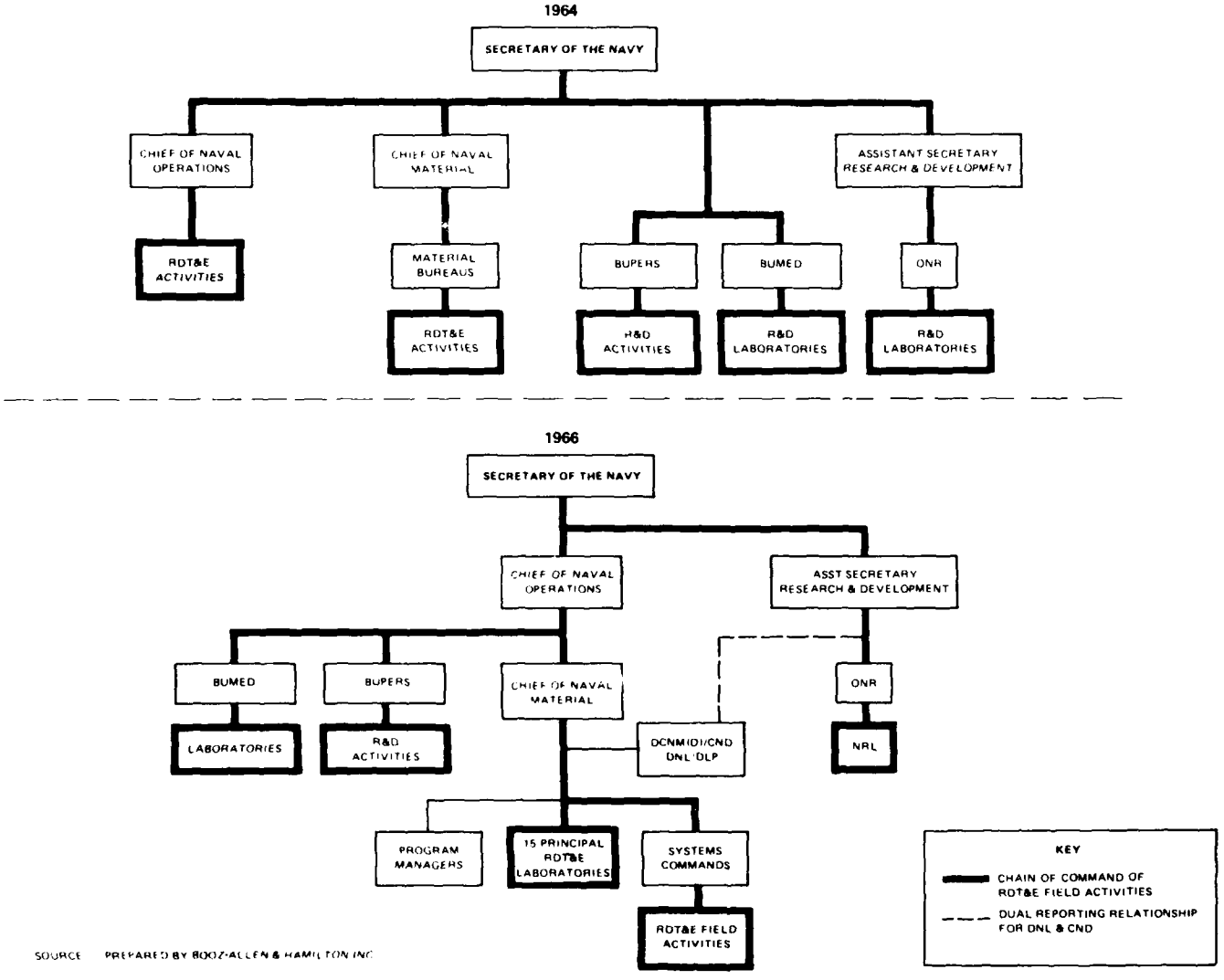
In short, this reflects the fact that assigning the laboratories to the CNM was fundamentally a compromise between those who preferred placing them directly under the civilian ASN(R&D) and those who feared that removing them completely from the military chain of command would reduce their responsiveness to Navy mission needs. Without completely accepting the Sherwin Plan's military/civilian cleavage, therefore, laboratory centralization under CNM offered a Navy solution to OSD demands that the status of the laboratories be raised, that their missions be broadened, and that some reporting echelons be eliminated. Simultaneously, management of the laboratories was separated from the program decisionmaking groups, i.e., the SYSCOMS.

The 15 major R&D laboratories which were transferred to CNM command and which were thereafter administered by the DLP are listed below in Exhibit II-4. Simultaneously, the laboratories were designated Class II activities, at the same reporting echelon with their former bosses, the bureaus, now SYSCOMS. Exhibit II-5 compares the old and new positions of the R&D laboratories within the Navy RDT&E organization.

EXHIBIT II-4
Principal R&D Laboratories Transferred to CNM Command 1966

Naval Air Development Center Johnsville, Pennsylvania	Navy Marine Engieering Laboratory Annapolis, Maryland
Naval Air Engineering Center Philadelphia, Pennsylvania	Naval Applied Science Laboratory Brooklyn, New York
Naval Ordnance Laboratory Corona, California	David W. Taylor Model Basin Carderock, Maryland
Naval Ordnance Test Station China Lake, California	Navy Underwater Sound Laboratory New London, Connecticut
Naval Underwater Weapons Research and Engineering Station Newport, Rhode Island	Navy Electronics Laboratory San Diego, California
Naval Ordnance Laboratory White Oak, Maryland	Navy Mine Defense Laboratory Panama City, Florida
Naval Civil Engineering Laboratory Port Hueneme, California	Naval Radiological Defense Laboratory San Francisco, California
Naval Weapons Laboratory Dahlgren, Virginia	

EXHIBIT II-5
Chain of Command for RDT&E Field Activities 1964 and 1966



SOURCE: PREPARED BY BOOZ-ALLEN & HAMILTON INC

The SYSCOMS referred to the transfer as "the great lab grab," and project managers balked at giving the Navy-wide laboratories broad and/or "challenging" program assignments. Their resistence was due largely to resentment and fear of the separation that had now been instituted between CNM's laboratory management responsibility and the SYSCOMS' continued program responsibility and accountability. In fact, the SYSCOMS did retain effective control over their former laboratories by virtue of their continued control of the major portion of R&D funds. On one hand, this meant continuity of control by small, vested interests, which precluded any coordination or meaningful systems, let alone program review by CNM. On the other hand, it permitted the SYSCOMS to continue to utilize the laboratories as they chose, more or less as before, or worse, to rely more and more on outside contracting, thereby further inhibiting the objective of creating and coordinating a centralized, "corporate" technical expertise through CNM.

The laboratories were themselves "schizophrenic" about the change. They had long argued to report above the bureau level and to be free of bureau tutelage. At the same time, some (less independent) laboratories enjoyed the bureaus' protection and patronage that afforded them both a focus for their work and funding in the "out" years. The laboratories removal from the aegis of the bureaus was also complicated by the general confusion and disharmony surrounding the Office of the DNL/DLP and the general CNM/SYSCOM conflict (discussed above).

CREATION OF RDT&E CENTERS

The consolidation and realignment of the laboratories by warfare area and across SYSCOM lines was another major but more evolutionary change effected in the Navy RDT&E complex after 1964. Like the earlier changes, it was also generated largely by pressures from outside the Navy Department, in particular, OSD.

Dr. Foster's Initiative

In November 1965, Dr. Foster (who had just replaced Dr. Brown as DDR&E) requested that the Services evaluate their R&D requirements in terms of what resources would be needed to attack the most pressing military problems and to specify which problem areas were suitable for lead laboratories and/or technical centers, a concept he was anxious to advance. Specifically, he asked them to:

- Develop five-to-ten top priority military R&D problem areas needing urgent and continuing attention for the next 10 years.

- Determine which of the problem areas developed are the most suitable for lead or systems laboratories or technical centers. Indicate any necessary construction at the lead sites and subsequent phaseouts of other sites.

- Outline the main functions that should be considered for performance in the lead DOD laboratories or technical centers.

- State what additional authorities or steps are required to make the new laboratories as effective as possible.[43]

The Navy's response was embodied in a preliminary "Navy Laboratory Report" submitted to the ASN(R&D) in January 1966 by a task force he had established under the direction of Dr. William P. Raney. The Report incorporated a preliminary indication of potential changes in mission responsibilities and an attempt to make logical designations for 'lead' laboratories.[44] Six Systems Development Centers were proposed with cognizance over discrete warfare problem areas; lead activities were also designated for each of 18 functions into which the problem areas were subdivided. An accompanying list of planned or accomplished closings or consolidations was also provided.

The Sheingold Report 1966

To evaluate the Services' plans, Dr. Foster established a Defense Science Board Committee that convened on May 10, 1966, and submitted its draft report (known as the Sheingold Report) in August. The Committee unequivocally endorsed the establishment of large weapons (systems) centers, each of which would embrace a broadly conceived technical program concentrated on a particular military problem area associated with general-purpose warfare. A center was defined as having a critical mass of specialists (about 1,000 per center) "drawn together into a single, comprehensive technical team." The basic underlying concept was that the center would be "a self-contained organization in that it would perform research and development with feasibility models as the end product. . . capable of demonstrating proof-of-function . . ." The center director would have firm control over the required resources (funding, manpower, facilities) and "report at a sufficiently high level to keep the 'echelon layering' to a minimum." The center would also be involved in "determination of military requirements associated with its mission," and initial procurement of equipments and would "provide support to the procurement agency when large-scale production is achieved." Major centers with broad developmental responsibilities would be backed up by other laboratories. Finally, "the over-all performance of the center would be critically evaluated on a periodic basis to

guarantee that the center would be a competitive organization with high performance standards and achievements."[45]

The Sheingold Committee noted a "considerable variation on the part of the Services in their willingness to *plan* for the establishment of weapons centers," and suggested the following reason:

> If there is a lack of enthusiasm for new centers, it is partially due to the many organizational changes that have taken place during the past few years and to the feeling that concentration on making the present system work better by examining the new management approaches would result in more progress.[46]

Referring specifically to the Navy, the Sheingold Committee suggested an ASW-Surface Systems Development Center (which would cover the spectrum of systems analysis and concepts; research, engineering development, prototype development; and initial procurement and development testing) as an example of a prototype center. Among the Committee's recommendations was that "the Navy conduct the required planning for establishing the first weapon center by 15 November 1966.[47]

Stimulus for hastening consolidation of laboratories into centers came at the end of the year. A DDR&E letter (dated 2 November 1966)* requested a response by January 1, 1967, on the Navy's progress with plans for strengthening its laboratories and particularly for "improving their capability for systems development management."[48] The CNM's plan for formation of the first six centers was forwarded to the ASN(R&D) in January 1967 via CNO. The latter endorsed the concept of "centers-of-excellence oriented toward various facets of naval warfare." He also carefully pointed out that research and development in science and technology were clearly functions of the laboratory complex; that systems engineering should also probably be assigned to them (vice the SYSCOMS); but that systems development management "appears to reside logically in the Systems Commands," and emphasis on this aspect in the centers should be critically scrutinized.[49] On 21 March 1967, the ASN(R&D) approved the plan, with some "reservations and qualifications," for implementation by July 1, 1967.[50]

Implementing the Change

The evolution of the RDT&E activities into centers, by consolidation, disestablishment, and reassignment, has been detailed in a report entitled "Realignments of the CNM RDT&E Facilities 1966-1970"[51] and an Addendum covering 1970-1975 and will not be

* It was a follow up to a letter of one year earlier requesting consideration of establishing technical centers capable of large systems developments.

reiterated here. In sum, the evolution, depicted in Exhibit II-6, constituted transformation and consolidation of the 15 CNM laboratories into nine RDT&E centers between 1967 and 1973. For the Navy, which had traditionally done a good deal of its development work in-house, the transformation of its laboratory complex along the lines laid down by OSD was at once controversial and relatively inconsequential. It did increase the laboratories' autonomy vis-a-vis the SYSCOMS by reducing the latter's ability to play one small laboratory off against another. It also effectively reduced the number of people with whom headquarters had to deal. Finally, it gave the department a welcomed opportunity to close three out-moded laboratories, a normally difficult task in the face of parochial congressional interests.*

Nevertheless, many disapproved the consolidations and believed they were largely cosmetic. Since centers could include laboratories that were not colocated, for example, the creation of a center sometimes simply meant an increase in personnel, layers of authority, and paperwork at the new "center" level, with all former laboratory-level management staff retained. Similarly, there was little impact on the tendency toward micromanagement, which was often perpetuated on both sides by fear of change and lingering hopes that the organization would revert back.[52]

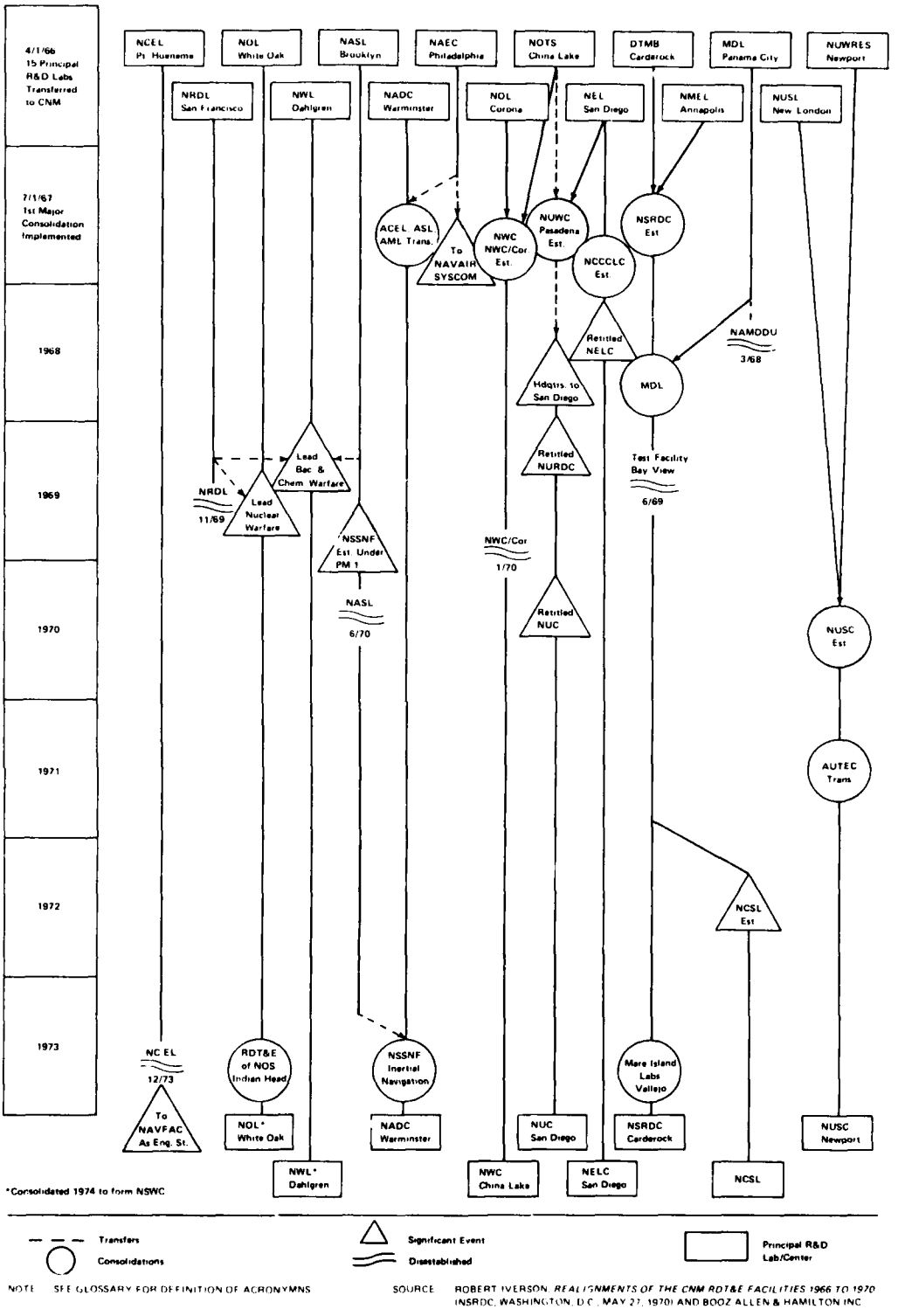
Furthermore, absorption into a new center complex was resented by those laboratories for whom it meant the loss of a former favored position with the SYSCOMS and/or effective "subordination" to the new center management staff that now came between them and CNM. Controversy also arose over the potential for intensified interlaboratory competition due to the elimination of direct ties with the SYSCOMS and new emphasis on nonoverlapping missions.

Most significant, however, was the continued reluctance on the part of the CNM and the SYSCOMS to turn over funds and program management to the RDT&E centers. The principle of assigning broad project management responsibilities to laboratories had long been a hotly debated issue in the Navy Department. While the SYSCOMS and the bureaus before them had frequently delegated authority to the laboratories for technical direction of projects, they had almost invariably retained overall project management control. In an environment that placed even greater emphasis on centralized control and accountability for project results, they were opposed to delegating more authority to laboratories that now reported to a third party.

Under increasing pressure from above (see sections below on laboratory studies after 1966), and in the face of the still strong resistance at headquarters, ASN(R&D) Dr. Robert Frosch eventually intervened personally to see that project management responsibility for two projects, Captor and Agile, was assigned to NOL and NWC,

* The three laboratories were NOL (Corona), NRDL (San Francisco), NASL (Brooklyn). It took 3 years to close them out completely.

EXHIBIT II-6
Evolution of the CNM Laboratories/Centers 1966-1973



NOTE SEE GLOSSARY FOR DEFINITION OF ACRONYMNS

SOURCE ROBERT IVERSON, *REALIGNMENTS OF THE CNM RDT&E FACILITIES 1966 TO 1970* (NSRDC, WASHINGTON, D.C., MAY 27, 1970) AND BOOZ ALLEN & HAMILTON INC

respectively. Further information on this and other aspects of laboratory utilization in the execution of R&D programs are addressed in Part V.

In assessing the conflict over assigning program management responsibilities to the laboratories, it should also be noted that not all laboratories wanted or sought them. Considerable administrative chores were involved, and some felt they interfered with technical laboratory operations. The question of whether or not the laboratories or centers had the necessary capabilities to undertake program management, with all its nontechnical ramifications, was also a long-standing unresolved issue.

LABORATORY STUDIES AND CHANGES 1966-1973

Before the results of the initial McNamara-Sherwin thrust could be fully assessed, DDR&E Dr. John Foster, launched another intensive round of defense in-house laboratory studies that continued beyond 1973. While this indicated continuing high-level interest in resolving laboratory issues, it simultaneously testified to the disappointing results of the previous studies. Moreover, the steady stream of review teams to whom the laboratory scientists and engineers had to respond and the shift in emphasis from study to study seemed to cause more disruption and instability than results. To provide insights into the status of the Navy laboratories at the end of the era, brief descriptions of these latter-day reviews and their impacts are presented in the sections below.

Problems of the In-House Laboratories and Possible Solutions 1966

As a first step toward defining problems that impeded improvement of the in-house laboratories effectiveness, Dr. Foster directed that the eight major studies conducted between 1962 and 1966 be reviewed and synthesized. In all, 95 problems were identified; 42 were determined "current and valid." The list was collated and sent to the three Services for analysis, comment, and proposed solutions. A summary of the Navy's position on the 42 problems is presented in Exhibit II-7; more detailed descriptions of the problems and the Navy comments are included in Appendix A.

Problems in the Management of Department of Defense In-House Laboratories 1967

After receiving in-house analyses and comments on the so-called 42 problems, DDR&E launched a concerted effort to solve them. This culminated in a comprehensive review that included visits by joint DOD-Civil Service Commission teams to 47 key defense laboratories. Managers, technical directors, and personnel officers explored personnel policies and manpower management that accounted for half of the 42

EXHIBIT II-7
Navy Department Positions on Problems of In-House Laboratories 1966

	Problem	Agreement	Action
1.1	Mission	Yes	Continuing
1.2	General Management and Policy	Yes	Continuing
1.3	Military Construction (MILCON)	Yes	Continuing
1.4	General Management and Policy (Planning)	Yes	Underway
1.5	General Management and Policy (Coupling)	Yes	Underway
1.6	Financial—Core Program	Yes	DDR&E
1.7	Organization and Controls—Supply and Procurement Systems	Yes	Continuing
1.8	Organization and Controls (Duplication)	Yes	Underway
1.9	Personnel—Military	Yes	Underway
1.10	Personnel—Recognition	Yes	Continuing
1.11	Financial—Fragmentation	Yes	Continuing
1.12	Personnel—Requirements	No	Continuing
1.13	Organization and Controls (Divided)	Yes	Continuing
1.14	Personnel—Security and Policy Reviews	Yes	DDR&E
1.15	Personnel—Authority	Yes	Underway
1.16	Personnel—Promotion to Management	Yes	No date
1.17	Organization and Controls—Rapid Rotation of Military Directors	No	None
1.18	Personnel—Recognition	Yes	No date
1.19	Personnel—Publicity of Examinations	Yes	Continuing
1.20	General Management and Policy—Coupling	Yes	Underway
2.1	Personnel (Compensation)	Yes	ODDR&E
2.2	Personnel (High Grades)	Yes	ODDR&E
2.3	Personnel—Authorized Strengths	Yes	7-67
2.4	Personnel (Marginal)	Yes	Continuing
2.5	Organization and Controls (Innovation)	Yes	Continuing
2.6	Organization and Controls (Laboratory Directors)	No	None
2.7	Program Development	Yes	7-67
2.8	Facilities	Yes	DDR&E
2.9	Financial (Controls)	Yes	6-67
2.10	Reporting Levels	No	None
2.11	Organization and Controls—Supply and Procurement Systems	Yes	Continuing
2.12	Personnel—Moving Expenses	No	Solved
2.13	Personnel—Interview Reimbursement	Yes	DDR&E
2.14	Personnel—Compensation	Yes	DDR&E
2.15	Personnel—Movement	Yes	Continuing
2.16	Personnel—Job Classification	Yes	Continuing
2.17	Financial—Fluctuations	Yes	DDR&E
2.18	Personnel (New Employees)	Yes	Continuing
2.19	Personnel—Processing Time	Yes	Continuing
2.20	Organization and Controls—Audits	Yes	DDR&E
2.21	Personnel—Summer Hires and Co-ops	No	Solved
2.22	Financial—Industrial Fund	Yes	1-67*

*Indicates target date for Service action.

SOURCE: PROBLEMS OF THE IN-HOUSE LABORATORIES AND POSSIBLE SOLUTIONS, OFFICE FOR LABORATORY MANAGEMENT (ODDR&E, OCTOBER 25, 1966) MAM 66-3.

problems. In all, 270 people were involved in this effort and contributed their views; over 30 problems (many with subproblems) were again identified, and action and action agents recommended. The major conclusion of the reviewers was that flexibility was the key to achieving maximum laboratory effectiveness. While flexibilities in the civil service system admittedly existed and were known to the laboratories, they were constrained by higher authorities from applying them. "It is possible to tailor a system of controls within the Federal Personnel System which is compatible with the need for a creative environment within technical organizations," noted the Civil Service Commission authors of the final report, "all that is necessary is the will to do it."[53] Solutions were required both at the Service level and higher levels of authority. Thirty-two actions were recommended specifically to the Navy Department; 12 were generally directed to the laboratories themselves.

Problems in the Management of Navy In-House Laboratories - Action Plan 1968

At the request of the Deputy Secretary of Defense, the Navy prepared an action plan dated December 14, 1968. Under the direction of the ASN(R&D), the Director of Civilian Manpower Management and the DNL developed a list of actions taken or recommended in response to the 1967 Civil Service Commission report. In transmitting the plan to the OSD, Navy Under Secretary Charles Baird noted that "unfortunately, we have made the least progress with regard to one of the more important items in the Commission's report, the coordination of work load, funds and manpower."[54] Among the reasons cited for this failure was the passage of the Revenue and Expenditure Control Act (PL90-364) that restricted efforts to remove personnel ceiling constraints. One of the proposed actions to provide additional latitude for improved coordination at the field–activity level was the adoption of the Navy Industrial Fund system of financial management in the CNM-commanded laboratories.

Navy Industrial Funding (NIF) and Resource Management Systems (RMS)

The need for improvement in financial management of RDT&E activities was a recurring theme in the laboratory studies of the 1960's. Major problems in this area were claimed to be (1) fragmented funding and task assignments which encouraged micromanagement and proliferation of rigid financial controls; (2) severe restrictions on reprogramming at the laboratory level; and (3) funding uncertainties due to budgetary procedures, fund deferrments, and delayed decisions.

As indicated above, the Navy Department had established the Independent Research/Independent Exploratory Development funds to provide laboratory directors with a descretionary "core program" to counterbalance some of the rigidity and uncertainty in the existing procedures. In the late sixties, Navy Industrial Funding (NIF) and

OSD-inspired Resource Management Systems (RMS) (see Chapter 14) were broadly introduced for the avowed purpose of making the laboratories' financial management more stable, uniform, businesslike, and flexible.

NIF had been introduced into NRL and NOL as early as 1953* and used in the Navy shipyards even earlier. The Naval Ship Research and Development Center (Carderock) was also converted to NIF before the major financial changes of the late sixties. The Navy therefore had some experience with it. On the other hand, as late as 1967 the financial systems of the majority of R&D laboratories were as disparate as their management history.

Fundamentally, NIF was a cost-accounting procedure coupled with a working capital fund. It was oriented to activities with several customers and was designed to charge them the actual cost of work performed for them (including overhead and general and administrative expenses) calculated on the basis of specific cost centers identified by the activity. The introduction of working capital revolving fund financed operations until reimbursed by customers.[55] OSD and OMB reviewed and approved an annual operating budget, and the activity submitted quarterly financial reports.

Because NIF was designed to improve resource allocation and cost accounting and to reveal true costs, it was believed NIF would encourage greater efficiency. The major problem in implementing NIF was the establishment of the "cost centers." This created a delicate problem for activities with sophisticated facilities, e.g., the large hyperballistics range (NOL) and the transonic tunnel (NSRDC) that were expensive to operate and to maintain. Past practice, by which overhead was distributed evenly throughout the laboratory, had permitted such facilities to be competitive, but it was feared that assignment of equitable overhead rates to such cost centers would effectively price them out of business.

In 1967-1968, RMS were instituted by OSD. In contrast to NIF, RMS lent itself to one-customer activities, financed primarily by an operating budget from its management command. Overhead in the RMS activities was applied either to all projects or assumed by its management command.

Significant features that NIF and RMS shared were:

- Accrual cost accounting
- Improved estimating and justifying of annual resource needs

* Inspired by the First Hoover Commission's attempt to promote cost accounting.

- Identification of all costs by end-product and performing activity
- A base for reporting performance of program and activities
- The capability for providing meaningful aggregations and summarizations of financial data to R&D managers throughtout the Navy.[56]

In its implementing directive, OSD required that all R&D activities be converted either to RMS or an equivalent working capital fund arrangement, i.e., NIF. In the interest of uniformity in the CNM laboratories Admiral Galantin, along with the SYSCOMS' financial staffs, ONR, and NAVCOMPT recommended that all CNM R&D laboratories be converted to NIF, which was more appropriate for multifunded activities.[57] The conversion was implemented effective July 1, 1969. Following a pilot test at the Naval Air Test Facility (Lakehurst) in 1970, the remaining 32 RDT&E activities, including Navy medical research units, ONR branch office, the Pacific Missile Range, etc., were all converted to RMS.

NIF's implementation in the CNM laboratories was very controversial. Opinions ranged from total approbation to total disapproval, but after several years of operation, there was "general agreement" that NIF offered some improvements. A former ONR Comptroller (who had previously opposed NIF) later concluded that "with the [RDT&E,N] program so proliferated. . .until and unless the Navy wants to block fund the laboratories, it will be necessary to maintain a sophisticated system like NIF. . .It is a very flexible system, can be expanded, contracted, or revised to accommodate change."[58] Nevertheless, some of the benefits of the NIF system were never fully experienced, because the laboratories continued to be plagued by discrepancies between available funding, personnel ceilings, and procedural rules that ran counter to the true spirit of NIF.[59]

Allocating Work, Funds, and Manpower to Department of Defense Laboratories 1969

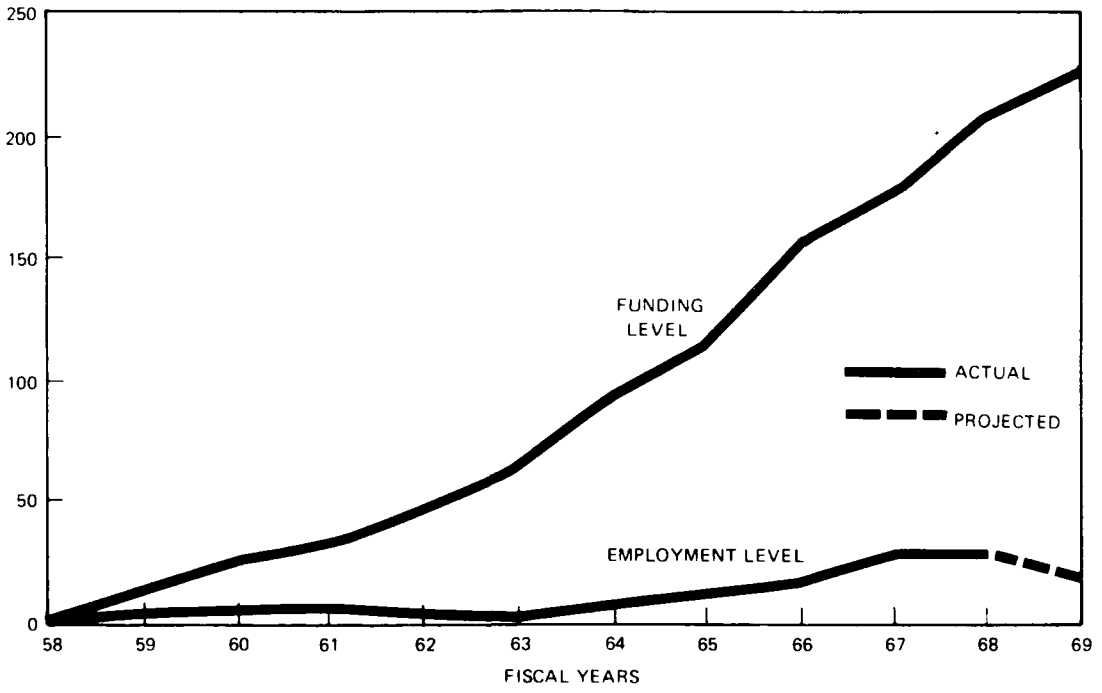
In 1969, Deputy Defense Secretary Packard called for a new assessment of the Planning, Programming, and Budgeting System (PPBS) (see Chapter 10), and specifically, how the coordination of manpower ceilings and allocations with funding and workloads was effected in the in-house laboratories. Following up on weaknesses identified by the Civil Service Commission, the General Accounting Office, and the military departments, he asked the Service Secretaries to submit detailed flow charts and explanations of key decision points in the process as it worked in selected laboratories.

Subsequently, the review group set up by OSD to evaluate the departments' inputs determined that there was little, if any, correlation of manpower requirement with

workloads and funds. Among the major causes of this mismatch was the fact that the manpower allocation process was carried out independently of program requirements and funding authorization. "Whereas manpower allocations follow one channel in the form of authorized ceiling strengths, programming and funding requirements followed a separate channel, and there is little relationship between the two."[60] The laboratories themselves tended to attribute the problem to "lack of decision or authority, at command and staff levels of management in the Military Departments with respect to laboratory requirements reaching those levels."[61]

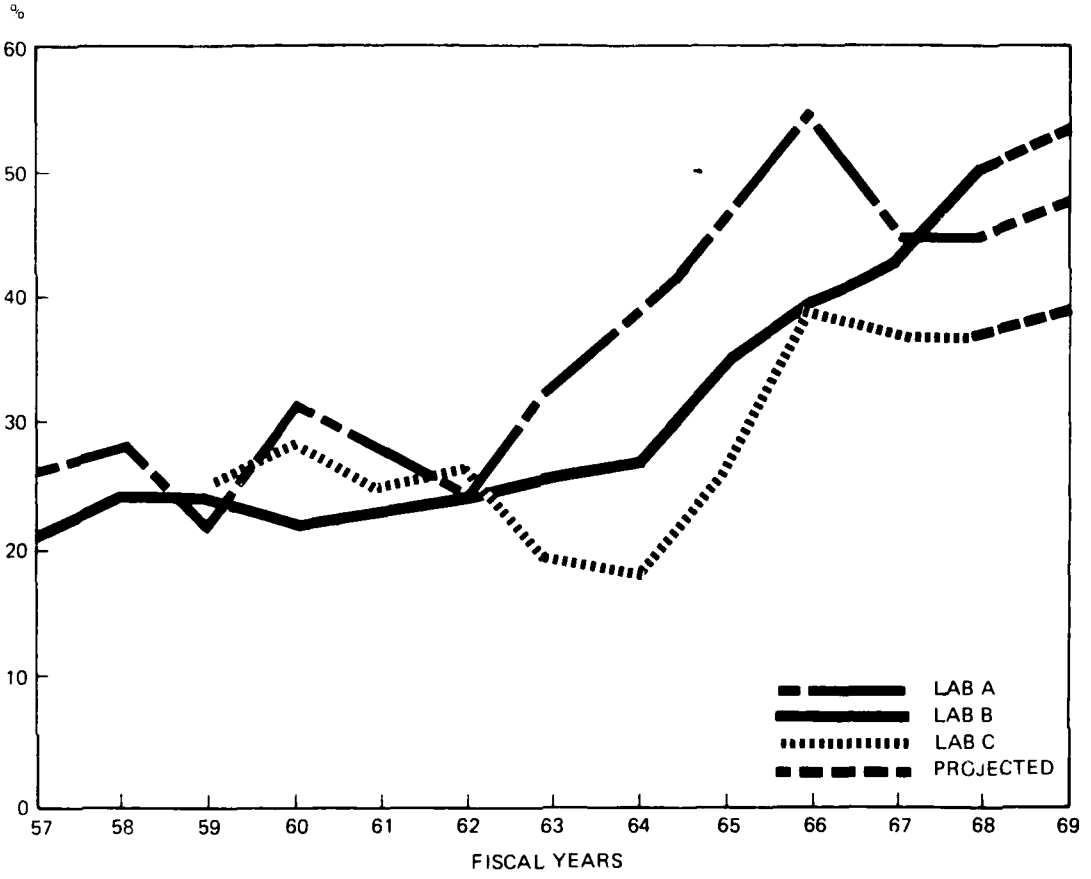
A vivid illustration of the effects of the mismatch is reproduced in Exhibit II-8, which shows the ever-widening gap between funding and staffing in the CNM laboratories. At least one symptom of the problem and its impact on the three laboratories selected was the gradual trend toward more out-of-house contracting, depicted in the accompanying Exhibit II-9.

EXHIBIT II-8
Percent Increase in Funding Level Compared With Percent Increase in Civilian Staffing Level at CNM Laboratories FY58-FY69



SOURCE "ALLOCATING WORK, FUNDS, AND MANPOWER TO DEPARTMENT OF DEFENSE LABORATORIES," MANAGEMENT ANALYSIS REPORT, OFFICE FOR LABORATORY MANAGEMENT, ODDR&E (WASHINGTON, D.C., 18 DECEMBER 1969), (MAR 69-7), P. 233.

EXHIBIT II-9
Increased Out-of-House Contracting (As Percent of Three Laboratories' Programs)



SOURCE: "ALLOCATING WORK, FUNDS, AND MANPOWER TO DEPARTMENT OF DEFENSE LABORATORIES," MANAGEMENT ANALYSIS REPORT, OFFICE FOR LABORATORY MANAGEMENT, ODDR&E (WASHINGTON, D.C., 18 DECEMBER 1969); (MAR 69-71), P. 234.

In addition to discrepancies in manpower, workloads, and funding, the OSD reviewers found that the actual coordination was "extremely complicated" with an almost unbelievably large number of individuals involved in each decision at all management levels, and many such levels between the laboratories and OSD. The organizational changes, increased "layering," and staff proliferation, discussed in Part I, had perhaps made this syndrome inevitable. In any case, it had become a "monumental task" to [illegible] coordination and approval of an idea or project and its associated resources. "[illegible] checks and balances is certainly desirable," they noted, "but, when a [illegible] is too large, stagnation can occur. We may be either at that point

With respect to the Navy, the review group noted that efforts were underway to improve the situation. For example, DLP had been given authority to adjust ceilings between laboratories to meet the demands of high priority programs. Furthermore, the CNM had established procedures in May 1969 for the exchange of workload planning information between sponsors and laboratories to give management more accurate workload predictions.[63]

To provide broader solutions to these problems, however, the review group made two key recommendations. First, that in the near future DDR&E "should assume responsibility for managing the DOD's in-house manpower resources for RDT&E activities by program element" (i.e., as funding was handled). Second, that a carefully controlled experiment known as Project REFLEX be implemented to determine if fiscal controls, without personnel ceiling controls, could be used effectively in defense laboratories.

Project REFLEX

The attempt to overcome what had become the constant mismatch between available funding and inadequate personnel ceilings was known as Project REFLEX (Resources Flexibility). The experiment ran from July 1, 1970 to June 30, 1973, during which time personnel ceilings were waived for the selected participating laboratories,* which, in turn, had to manage their manpower growth on the basis of money coming in. Unfortunately, the experiment came at a time of tight manpower ceilings, reductions in authorized civilian end strength, and hiring freezes throughout the Navy. As a result, some anticipated manpower constraints were imposed on the REFLEX laboratories and in some cases, they grew at the expense of other activities. To overcome these problems, OSD made some adjustments in personnel ceilings, but they remained a limiting fact of life throughout the military laboratories.

All REFLEX laboratory managers considered the experiment a success in terms of creating a flexible environment to meet rapid change and of improving personnel management. They also conceded that some of the benefits, e.g., economies, could have been achieved through good management practices without REFLEX.[64]

Dr. Joel Lawson, DNL, submitted his evaluation of Project REFLEX in 1973. It cited the following results:

- Better balance between funded programmed employment levels
- Greater cost sensitivity and enhanced realism in the laboratory planning process

* The Navy laboratories participating in Project REFLEX were Naval Undersea Center, Naval Underwater Systems Center, and Naval Weapons Laboratory.

- Heightened sense of responsibility and accomplishment as well as development and ability to evaluate middle managers

- Improved manpower practices by removing pressures to hire on calendar ceiling or other nonprogram bases

- Ability to assume programs not possible before and to be more responsive to sponsor requirements, especially in the area of fleet support.[65]

To back up his conclusions, Dr. Lawson included comparisons of manpower and incurred costs in the REFLEX laboratories and non-REFLEX laboratories that show that the former experienced increases in personnel accompanied by a consistently higher percentage of work performed in-house.

In 1973, the General Accounting Office (GAO) made an independent evaluation of Project REFLEX to identify for Congress the benefits management achieved with fiscal controls and without personnel ceilings. Recognizing that no valid means of measuring the project's success had been developed, the GAO concluded on the basis of their investigation and department reports that benefits had been realized in planning for and managing R&D laboratories. Named among other specific advantages were:

- Encouraged delegation of responsibility and authority to lower management levels

- Provision to management of more options

- Improvement of both technology advancement in-house and technical direction of contractors

- Alleviation of time-consuming administrative chores at higher management levels.[66]

The GAO concurred with recommendations, such as that of DNL, Dr. Lawson, that the test of management through fiscal controls be continued and extended, preferably according to OMB-established criteria and guidelines. "Even in the laboratory environment, for which effective productivity measurements have not yet been devised, the test of entrusting local managers with authority and responsibility for conducting their operations with fiscal controls improved management."[67]

In spite of recommendations of the GAO, the DNL, and other top-level officials thoughout DOD, the REFLEX experiment was never extended. This was due, in large part, to the implied potential for having to operate the laboratories outside the civil

service, since funding cutbacks would, by definition, cause corresponding reductions of personnel or closing of laboratories.

The Blue Ribbon Defense Panel Report 1970

The Blue Ribbon Defense Panel, chaired by Gilbert W. Fitzhugh, was appointed in July 1969 by the President and the new Defense Secretary, Melvin Laird, with a broad charter to address inadequacies in organization and operating procedures of the entire DOD. With respect to the defense laboratories, the Panel concluded that their productivity appeared low compared to the investment in them, that they were unsystematically organized, with fragmentation along technology lines, that they suffered from a rigid personnel system that inhibited qualitative improvements to the technical staff, and that further consolidations were badly needed. In addition, a possible conflict of interest was thought to exist between the defense laboratories' roles as developers and as administrators of contracts with private companies.

Among the Panel's 113 recommendations, three directly concerned the defense laboratories. First, ARPA should be delegated responsibility for all Research and Exploratory Development funds; second, a review of defense in-house laboratories and test and evaluation centers should be made by ARPA and the proposed Defense Test Agency, with a view to eliminating nonessential ones and consolidating the remainder across Service lines; and third, attention should be given to possibly transforming some defense activities into government-owned contractor-operated installations. As a result of the Panel's strong representations against the quality of the defense laboratories, a Task Group on Defense In-House Laboratories* was appointed by the Deputy Secretary of Defense and the DDR&E to identify which actions should be taken as recommended by the Blue Ribbon Defense Panel.

The Glass Committee Report 1971

The Task Group on Defense In-House Laboratories (which became known as the Glass Committee after its Chairman, E.M. Glass, Office of DDR&E) was appointed in February 1971. Its final report was issued July 1, 1971.

In general, the Glass Committee refuted the Panel's findings, citing its failure to visit any laboratories and to provide any supporting information for its conclusions. The laboratories had in fact made many contributions, noted the Committee, and positive steps had been taken to improve their quality. Nevertheless, additional actions to further

*Task groups on test and evaluation centers and FCRCs were also formed.

this end were possible. Twenty-nine recommendations were offered under the following four headings: Assessment of Roles and Performance, The People Problem, Administrative Reforms, and Restructuring of Defense RDT&E Organization.[68] As an integral part of the Glass Committee review, a 5-year, time-phased plan of action was developed and submitted by each military department.

In its plan, prepared by Dr. Joel Lawson, DNL, the Navy supported most of the recommendations of the Glass Committee report. Major emphasis was placed on clarifying the roles and missions of the in-house laboratories, including areas of primary responsibility; increasing IED funds and introducing a similar program of independent advanced development; expanding use of cheaper demonstration-of-feasibility prototypes as interim evaluation models; upgrading technical and management expertise and its utilization; and enhancing active laboratory participation in formulation and execution of programs and related support to sponsors.

In an effort to ensure implementation of the proposed plans, the Deputy Secretary of Defense followed up the Glass report with a request that a "State of the Laboratories" report be submitted by each department in the fall of 1972. The Navy Department's report provided examples of specific accomplishments during the year, recommendations for future OSD actions, and a progress report on Navy actions taken to implement the Glass Committee recommendations. Highlights of that report, prepared by DNL are useful as a final accounting and indication of the direction in which management and utilization of the Navy's in-house laboratories were heading at the close of the era.

Of the original 29 Glass Committee recommendations, the DNL reported that eight were completed, and an equal number were "continuing" or lacked any significant accomplishments to date. Among those reported completed were (1) upgrading R&D laboratories and centers to the "Major Command List" for military personnel; (2) rewriting mission statements for all laboratories* and designating lead laboratories; (3) allocating $15 to $20 million of Exploratory Development money directly from the Naval Material Command Headquarters to the CNM laboratories; and (4) assigning program management through the development phases of Captor and Agile, plus major responsibility for portions of other weapons development programs to laboratories.[69]**

Falling into the category of those recommendations subject to Navy action, but for which no accomplishment could yet be reported, were several problems:

- An overall statement of and directive on top-level Department-wide management and utilization of the in-house laboratories

* They were still considered by many to be too broad and ill-defined.

** This last "accomplishment" proved unworkable, and Agile was cancelled while Captor reverted to BuOrd.

- Establishment of the Independent Advanced Development program budget element

- Expansion of the roles of in-house laboratories as project managers and/or technical directors of equipments and weapons in which the need for creative engineering competence outweighed any requirements arising from administrative and system complexity

- Limitation of audits, inspections, and reviews of in-house laboratories to one specified month per year that would be designated "open season" for such interruptions to normal laboratory operations

- Assignment of greater authority to laboratory directors for procurement to satisfy their R&D needs.

Other major Glass Committee recommendations, requiring OSD and congressional action, similarly remained unimplemented through 1973.

Notes to Chapter 8

1. Personal Interview.
2. Speech by W.B. Foster, American University, April, 1963.
3. Remarks by the Honorable Harold Brown, DDR&E, "Research and Engineering in the Defense Laboratories," Naval Research Laboratory, Washington, D.C., October 19, 1961.
4. Ibid.
5. Ibid.
6. Memorandum, Secretary of Defense Robert S. McNamara to the Service Secretaries, Subject: In-House Laboratories, October 14, 1961.
7. Bureau of the Budget, *Report to the President on Government Contracting for Research and Development* (Washington, D.C., 1962).
8. Ibid., Accompanying cover letter to the President.
9. Letters from Commanding Officer and Director USNUSL to Assistant Chief (R&D), BuShips, March 19, 1963; Letter from Commanding Officer, NEL, to Assistant Chief (R&D), BuShips, March 28, 1963.
10. C.C. Furnas, Chairman, *A Report of the Defense Science Board on Government In-House Laboratories*, (Washington, D.C., 6 September 1962) cited in Robert J. Mindak, *Management Studies and Their Effect on Navy R&D* Office of Naval Research (Arlington, Va. 1 November 1974), Section II, pp. 76-78.
11. Department of the Navy, *Review of Management of the Department of the Navy, Research and Development Management Study*, Vol. II, Study 3, (Washington, D.C., October 1962), pp. 179-180.

12. Ibid. p.30.

13. Office of the Director of Defense Research and Engineering, "Report of the Task Force Group on Defense In-House Laboratories" (Washington, D.C., July 1971) (Hereinafter cited as *Glass Report*).

14. Memorandum, RADM E.A. Ruckner to ASN(R&D), Subject: An Analysis of Some Recent Reports Dealing with Laboratory Management undated; (Draft report enclosed).

15. SECNAV Instruction 3900.13A, Subject: Management of Navy R&D Laboratories, November 1, 1963.

16. Personal Interviews.

17. Ruckner Memorandum.

18. OPNAV Instruction 3900.18, Subject: Research and Development Activities, April 23, 1962.

19. *Glass Report*, pp. 63-64.

20. Personal Interview.

21. Ibid; *Glass Report*, op. cit. pp. 63-64.

22. Memorandum, Secretary of Defense Robert McNamara to the Service Secretaries, Subject: A Plan for Management of the Principal DOD In-House Laboratories, November 16 1964, Enclosure (Hereinafter cited as *Sherwin Plan*); Personal Interview.

23. *Sherwin Plan*.

24. "A Proposed Plan for the Organization of the Principal Navy In-House Laboratories," November 16, 1964, pp. 5, 12. (Appended to *Sherwin Plan*).

25. Memorandum, Secretary of Defense Robert S. McNamara to DDR&E, Subject: Management of DOD In-House Laboratories, November 20, 1964.

26. Personal Interview.

27. Memorandum, DDR&E Harold Brown to Service Secretaries, Subject: Management of DOD In-House Laboratories, November 25, 1964.

28. Memorandum, ASN(R&D) Robert Morse to SECNAV, Subject: Management of Navy Laboratories, January 4, 1965 and Enclosure (1), "On the Management of Navy Laboratories."

29. Ibid., pp. 13-14.

30. See Mat03 Comments on Sherwin Plan, (DNL files).

31. Memorandum, ASN(R&D) Robert Morse to SECNAV, January 4, 1965.

32. Ibid, Enclosure (1), "On the Management of Navy Laboratories."

33. Ibid., p. 12.

34. SECNAV Instruction 5430.77, Subject: Establishment of Director of Navy Laboratories, December 20, 1965; NAVMAT Instruction 5430.26, Subject: Establishment of Director of Navy Laboratory Programs, April 26, 1966.

35. Personal Interview.

36. Personal Interview.

37. Personal Interview.

38. Personal Interview.

39. Personal Interview.

40. "Proposed Revision of DNL Charter," June 9, 1969 (From the files of Capt. B. L. Towle.)

41. Personal Interview.

42. Memorandum, Admiral J.J. Galantin, CNM, Subject: Military Command of Certain R&D Laboratories, March 18, 1966 (Hereinafter cited as *Sheingold Report*).

43. Defense Science Board, "Report of the Committee on In-House Laboratories," (draft), August 19, 1966.

44. "Navy Laboratory Report," unpublished MS, In-House review (for official use only), January 1966.

45. *Sheingold Report*, p. 9.

46. Ibid., p. 8.

47. Ibid., p. 18.

48. Memorandum, CNM to ASN(R&D) via CNO, Subject: A Plan for the Improved Utilization of Navy Laboratory Resources, January 24, 1967.

49. Memorandum, CNO to ASN(R&D), Subject: A Plan for the Improved Utilization of Navy Laboratory Resources, February 8, 1967.

50. Memorandum, ASN(R&D) to CNM, Subject: A Plan for the Improved Utilization of Navy Laboratory Resources, March 21, 1967.

51. Robert Iverson, *Realignments of the CNM RDT&E Facilities, 1966-1970*, NSRDC, (Washington, D.C., May 27, 1970) and Addendum for the Period 1970-1975, (draft, Washington, D.C., Dec. 2, 1974).

52. Personal Interview.

53. U.S., Civil Service Commission, *Problems in the Management of Department of Defense In-House Laboratories*, Prepared for the Bureau of Inspections, (Washington, D.C., December 27, 1967), p. 1-2.

54. Assistant Secretary of the Navy (R&D), "Final Report: Problems in the Management of In-House Laboratories–Action Plan" (Washington, D.C., December 14, 1968).

55. Memorandum to ASN(R&D), Subject: ASN(FM) Query Regarding Need for NIF at R&D Activities, and Enclosures, from Donald Rehorst, Special Assistant (Financial Management) to ASN(R&D), August 27, 1975.

56. Ibid.

57. Personal Interview and Memorandum, T.C. Lornquest to Robert Frosch ASN(R&D), Subject: Meeting with Dr. Foster re: Budgeting under the Anthony System, April 13, 1967.

58. Ibid.

59. Personal Interview.

60. "Allocating Work, Funds and Manpower to Department of Defense Laboratories," Director of Defense Research and Engineering, Office for Laboratory Management, (Washington, D.C., December 18, 1969), March 69-7, p. 2.

61. Ibid.

62. Ibid., p. 36.

63. Ibid., p. 2.

64. General Accounting Office, *Project REFLEX - A Demonstration of Management Through Use of Fiscal Controls Without Personnel Ceilings,* (Washington, D.C., June 21, 1974), p. 67; Personal Interview.

65. Director of Navy Laboratories, *Evaluation of Project REFLEX Within the Navy,* (Washington, D.C., August 1973).

66. GAO, "Project REFLEX," p. 2.

67. Ibid., p. 69.

68. Glass Report, Annexes A, B, D, E, and F (July 1, 1971).

69. Memorandum, Director of Navy Laboratories, to ASN(R&D), Subject: "Navy Plan for Improving Its In-House Laboratories," May 25, 1971 (draft plan enclosed).

SUMMARY

PRINCIPAL TRENDS IN NAVY RDT&E FIELD ACTIVITIES 1946-1973

Major milestones in the postwar evolution of Navy RDT&E field activity management are displayed in Exhibit II-10. Emphasis was placed on those relating primarily to R&D laboratories vice test and engineering stations. In addition to noteworthy events, the diachronic chart pinpoints the many reviews and studies that addressed laboratory issues throughout the era. A separate summary of the major studies is also presented in Exhibit II-11.

A cursory glance at the milestone chart reveals the most obvious feature of the postwar laboratory environment: a decade of relative stability, followed by steadily intensifying activity and preoccupation at all levels with the in-house R&D laboratories. Attending this development were organizational changes which gradually transformed simple and direct lines of responsibility and authority into diffused and complex relationships. Ironically, the changes were often motivated by a desire to elevate the laboratories' status in the face of the general drift upward of authority occurring throughout DOD and the Navy.

Underlying the major events between 1946 and 1973 was also the long-term transition from relatively narrowly focused laboratories to more general-purpose "corporate" weapons systems centers. A further manifestation of the top-down emphasis on improving the laboratory environment, this trend was also accompanied throughout the second half of the era by some modifications in laboratory funding, task assignments, and personnel management. The following paragraphs summarize these trends and some of their long-range impacts on Navy laboratory management.

POSTWAR STABILITY

Throughout the decade following World War II, Navy in-house laboratory management was decentralized and relatively clearcut. RDT&E field activities reported directly to the bureaus for whom they were established to fulfill the material requirements of their respective fleet support missions. Consistent with this basic principle, the bureau chiefs exercised virtually exclusive authority, responsibility, and management control over the laboratories. Lines of communication and reporting between the laboratories and their parent bureaus were as simple and direct as the lines of authority and responsibility.

The bureaus viewed this management relationship as an appropriate congruence of responsibility, authority, and responsiveness to fleet needs. From the laboratory technical director's vantage point, the extent and some of the virtue in this regime were reflected not only in the clearcut management relationships, but also in his own access to higher level authorities. In fact, during this period, only the bureau chief and perhaps his assistant chief for R&D stood between the technical director and the Secretary of the Navy. On the other hand, some technical directors felt that a one-to-one relationship with the bureau too often resulted in the laboratory's subjugation to counter-productive, bureau-imposed constraints and restrictions.

The stability of the arrangement was evidenced by the virtual absence of major milestones in the evolution of the laboratory complex between 1946 and 1960. Nevertheless, the events and studies depicted in Exhibit II-10 for that period actually reflect several problems:

- Attracting and retaining technical manpower
- Military/civilian relationships
- Funding flexibility and discretionary authority at the laboratory level
- Challenging task assignments and optimum utilization of the laboratories
- Mission definition
- The delicate balance between top-level attention to the laboratories and micromanagement.

Handling of these issues differed from bureau to bureau. During the fifties, BuOrd established Foundational Research funds and instituted laboratory operating principles based on joint military/civilian responsibilities; BuShips established a central focal point at headquarters for laboratory affairs.

For its part, the legislative branch broached the civil service problems by providing additional supergrade positions for R&D personnel. The Riehlman Committee and the Hoover Commission aired military/civilian interface problems and utilization of the technical laboratories, respectively, but few changes were introduced as a result. In fact, many of the problems intensified or simply went unresolved, indicating that the stability of the fifties was at least partly attributable to inertia and management acceptance of the status quo. It also suggested the difficult nature of the issues and was a harbinger of the coming turmoil in the defense in-house laboratories.

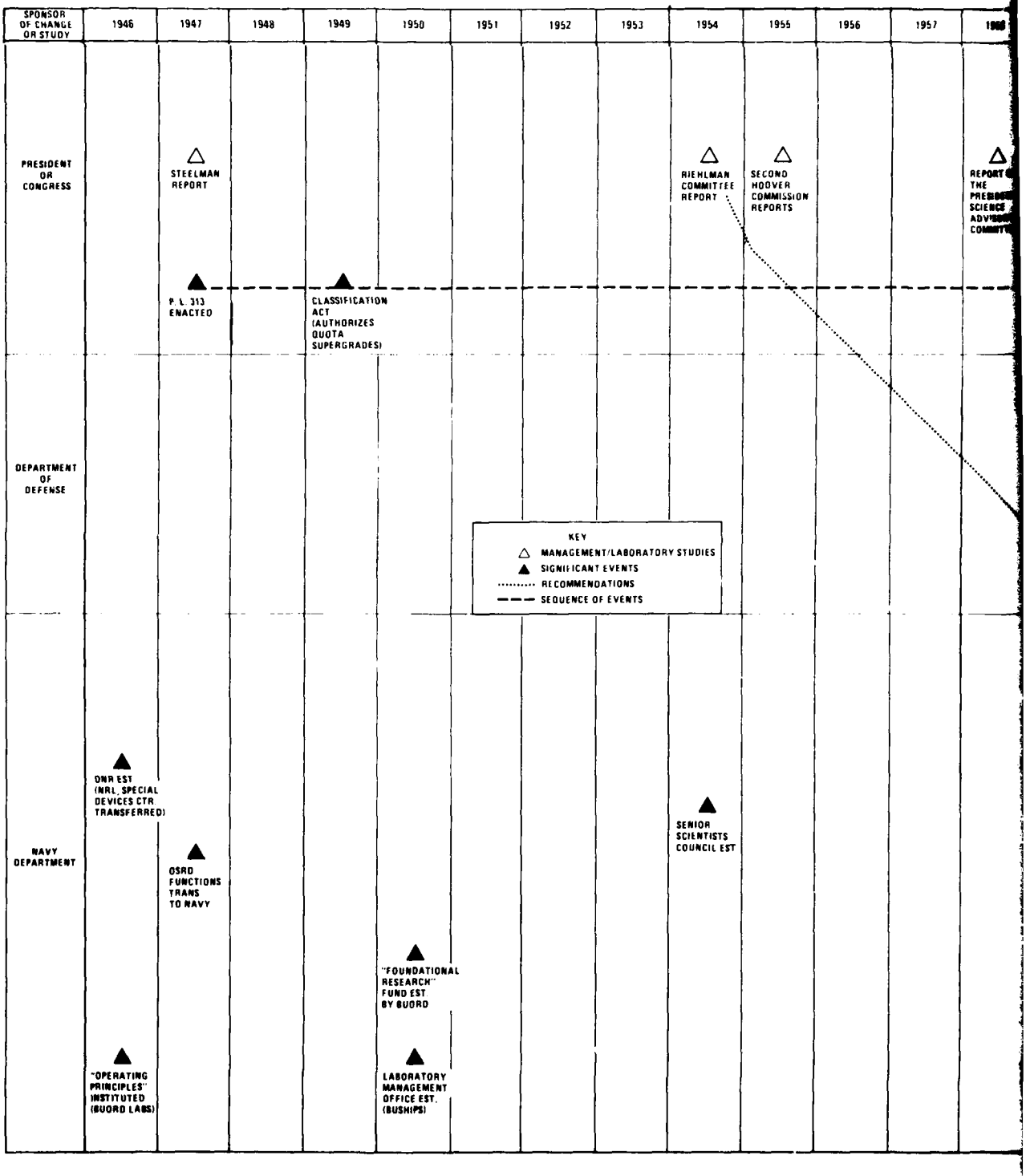

SPONSOR OF CHANGE OR STUDY
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STEELMAN REPORT
RIEHLMAN COMMITTEE REPORT
SECOND HOOVER COMMISSION REPORTS
P. L. 313 ENACTED
CLASSIFICATION ACT (AUTHORIZES QUOTA SUPERGRADES)
DEPARTMENT OF DEFENSE
KEY
MANAGEMENT/LABORATORY STUDIES
SIGNIFICANT EVENTS
RECOMMENDATIONS
SEQUENCE OF EVENTS
NAVY DEPARTMENT
ONR EST (NRL, SPECIAL DEVICES CTR TRANSFERRED)
OSRD FUNCTIONS TRANS TO NAVY
SENIOR SCIENTISTS COUNCIL EST
"FOUNDATIONAL RESEARCH" FUND EST BY BUORD
"OPERATING PRINCIPLES" INSTITUTED (BUORD LABS)
LABORATORY MANAGEMENT OFFICE EST. (BUSHIPS)

EXHIBIT II-10
Significant Milestones for Na y RDT&E
Field Activities 1946-1973

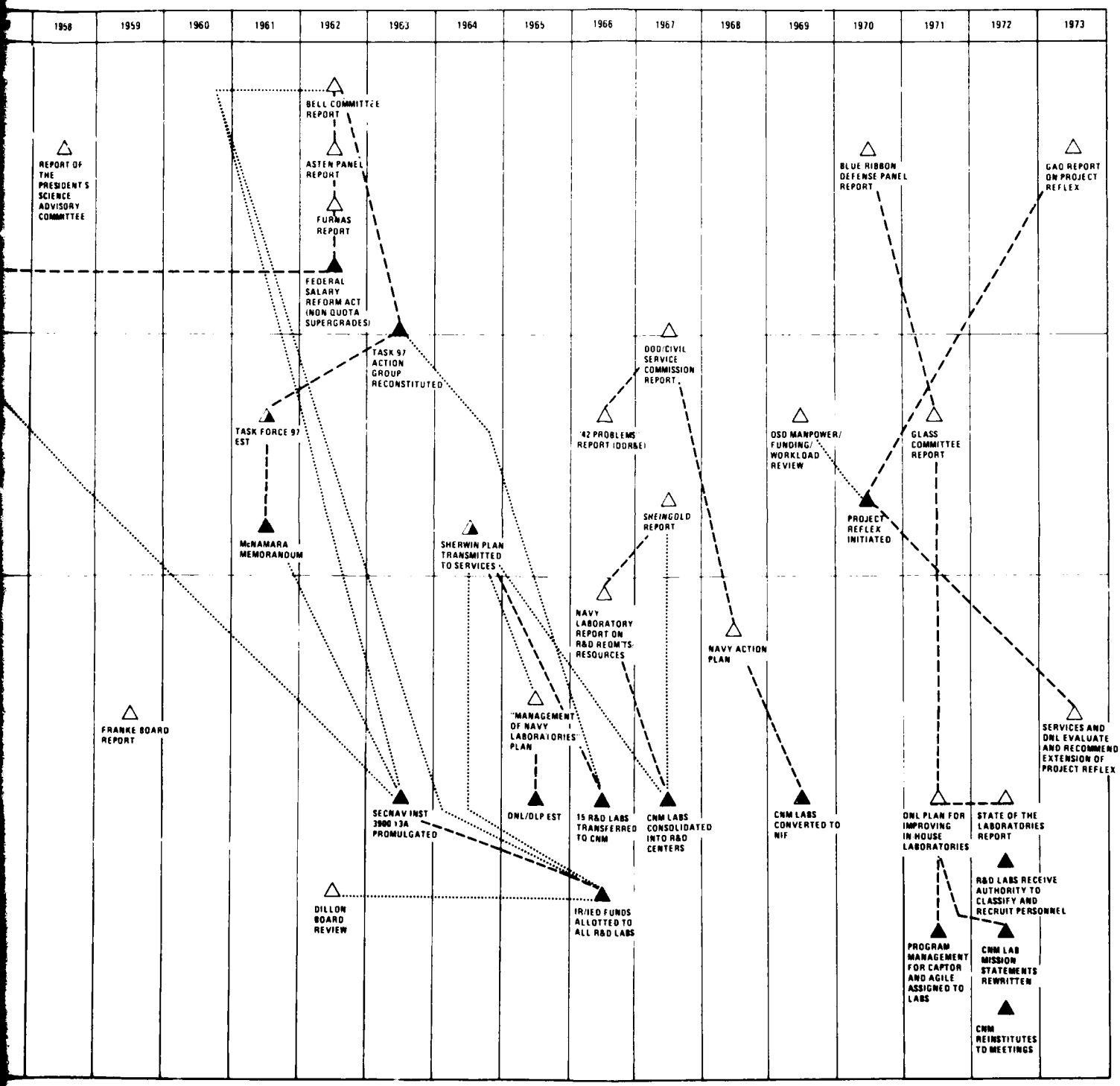


EXHIBIT II-11
Summary Chart of Studies Bearing on Defense In-House Laboratories

Date	Name of Study	For	Conducted by	Purpose and Scope
1947	Steelman Report	President	President's Scientific Research Board	A comprehensive review of science and public policy including research administration, personnel problems, and the Government's policy.
4 August 1954	Riehlman Subcommittee	Congress	Subcommittee of Committee on Government Operations	Organization and administration of R&D in DOD.
May 1955	Second Hoover Commission	Congress	Commission chaired by Herbert Hoover	Comprehensive review of the Executive Branch of the Government.
1958	Strengthening American Science	President	President's Science Advisory Committee	Report on the federal government's role in science and technology.
31 January 1959	Franke Board	SECNAV	In-house committee on organization of the DON	Review of organization of the Navy in view of DOD Reorganization Act of 1958 and technological advances since the Gates report.
1961/1962	Task Force 97	SECDEF	In-house committee chaired by Deputy DDR&E	Review of operations of in-house laboratories and recommendations of changes.
17 May 1962	Bell Report	President/Congress	Cabinet-level committee chaired by D. Bell, Director, Bureau of Budget	Comprehensive review of Government contracting for R&D to improve effectiveness.
April 1962	Astin Panel	Federal Council for Science and Technology	Standing Committee of FCST	Study of factors affecting ability to select, recruit, develop, and retain superior scientific and engineering personnel in the Federal Government.
6 September 1962	Furnas Report	SECDEF	Defense Science Board Subcommittee	Review of "health" of DOD laboratories and recommendations of improvements. Also review of Bell report and development of recommendations.
15 December 1962	Dillon Review	SECNAV	Committee of in-house representatives and consultants	Comprehensive review of entire Navy organization; in-depth review of functions and operations down to and within bureaus and offices.
1963	Task 97 Action Group	OSD	DOD/Civil Service Commission	Review and followup on problems and recommendations identified in earlier studies/reports.
November 1964	Sherwin Plan	DDR&E	Chalmers Sherwin (Deputy DDR&E)	Improvement of operation and management of DOD in-house laboratories.
4 January 1965	On the Management of Navy Laboratories	SECDEF	Dr. Robert Morse, ASN(R&D)	Navy Department response to Sherwin Plan based on five in-house task group studies by Radm. Ruckner, et. al.
January 1966	Navy Laboratory Report	DDR&E	Dr. Robert Morse, ASN(R&D)	Navy Department response to DDR&E on future priority R&D requirements and in-house capabilities.
August 1966	DSB Report on In-House Laboratories	DDR&E	Defense Science Board Committee	To evaluate services' 10-year plans for meeting top priority problems and developing effective laboratories and weapons systems centers.

EXHIBIT II-11 (Continued)

Date	Name of Study	For	Conducted by	Purpose and Scope
25 October 1966	Problems of the In-House Laboratories and Possible Solutions "42 Problems"	DDR&E	Office for Laboratory Management (ODDR&E)	Review and collate problems identified in eight major studies between 1962 to 1966.
27 December 1967	Problems in the Management of Department of Defense In-House Laboratories	CSC and DDR&E	DOD/Civil Service Commission	Visit 47 key defense laboratories to identify, review, and resolve personnel management problems.
14 December 1968	Action Plan	Deputy SECDEF	ASN(R&D)	Describe actions taken or proposed by the Navy to resolve personnel problems identified in 1967 CSC report.
18 December 1969	Allocating Work, Funds, and Manpower to DOD Laboratories	Deputy SECDEF	SECNAV (In-House Task Groups for Navy)	Explanation and review of PPBS as it pertained to allocating work, funds, and manpower to the Navy Laboratories - incorporated into OSD evaluation and coordinated DOD-wide review.
27 May 1970	Realignment of the CNM RDT&E Facilities 1966-1970 (and Addendum 1970-1975)	NSRDC	NAVMAT	Review of the status and proposed plans for creation of major mission-oriented cente
1 July 1970	Blue Ribbon Defense Panel	President/SECDEF	Distinguished out-of-house committee	Study of entire organization and structure of DOD.
1971	Plan for Improving the Effectiveness and Utilization of the Navy's In-House Laboratories	DDR&E	DNL	5-year, time-phased Navy plan of action for improving its laboratories - integrated into 1971 Glass Committee review.
1 July 1971	Glass Committee	SECDEF	In-house group chaired by Dr. Glass	Review of BRDP report and review of DOD laboratories and Service recommendations and plans for their improvement.
18 August 1972	State of the Laboratories	Deputy SECDEF	DNL	Status report on implementation of proposed plans and Glass Committee recommendations for improving the laboratories.
August 1973	Evaluation of Project REFLEX within the Navy	Navy	DNL	Evaluation and recommendations regarding the 3-year demonstration experiment directed by DDR&E and conducted in three Navy laboratories.
1973	Project REFLEX--A demonstration of Management through use of Fiscal Controls without personnel ceilings (DOD)	Congress	Comptroller General of the U.S. (General Accounting Office)	Evaluation of the effect of the Project REFLEX experiment with recommendations.

INCREASED MANAGEMENT ATTENTION TO THE IN-HOUSE LABORATORIES

The centralized authority in OSD for RDT&E during McNamara's incumbency was described in Part I. Its implication for the Navy laboratories was felt initially in a burst of top-level attention which launched a decade-long trend toward increased OSD involvement in policies affecting their management and utilization. Post-Sputnik shockwaves triggered a searching reexamination of the nation's scientific program, in general, and its military R&D capabilities, in particular. The spate of outside studies evaluating the defense in-house laboratories over the next 5 years reflected the atmosphere of concern over their effective utilization.

At the inception of his tenure as Secretary of Defense, McNamara announced his firm intention to take action necessary to improve the defense in-house laboratories. In 1961, the establishment of Task Force 97 to identify outstanding issues and make recommendations presaged future extensive OSD preoccupation with the service laboratories. While several subsequent efforts were carried out in conjunction with or at the behest of outside authorities (e.g., Civil Service, Congress, the President) the majority were inspired within OSD/DDR&E ranks, consistent with the tendency to assume decisionmaking authority Department-wide.

A corollary to active OSD interest in defense R&D laboratories was progressively greater top-level Navy management attention to and modification of their organization and operation. While modifications were frequently generated from above,(OSD), specific changes were usually internally defined. The momentum of OSD's preoccupation and its impact on the Navy is graphically illustrated in Exhibit II-10 not only by the sheer number of events, studies, and changes in the Navy laboratory community after 1962, but also by the obvious top to bottom, action/reaction pattern depicted by the lines which linked events and studies. Both contrasted sharply with the virtual absence of change and influence from above or within during the fifties.

In addition to the proliferation of studies, the tendency toward greater top-level attention to and involvement with the Navy laboratories produced several significant trends. These are summarized in the following sections.

CHANGES IN ORGANIZATION AND MANAGEMENT RELATIONSHIPS

The increasing preoccupation with improvement of the in-house laboratories ultimately resulted in several major organizational changes. In response to OSD policy mandates to provide sustained top-level attention and raise the R&D laboratories' status, the Navy Department established in 1965 a civilian Director of Navy Laboratories (DNL). He reported to the ASN(R&D) and served as a focal point in headquarters for laboratory

policy. The new DNL was also double-hatted as the Director of Laboratory Programs, in which role he reported to the Deputy Chief of Naval Material (Development) and was nominally responsible for the in-house Exploratory Development technical program and laboratory administration.

These steps were followed in 1966 with the transfer of command and management control of the 15 principal R&D laboratories from the bureaus/SYSCOMS to the Chief of Naval Material. Organizationally, the laboratories were now placed on the same level as their former sponsors, the systems commands.

One important result of the change was the development of an incipient dichotomy between the SYSCOMS and the R&D laboratories. While the SYSCOMS retained control over the bulk of the R&D program and coincidentally, the bulk of R&D funds, the laboratories reported to a higher management level. This raised questions of accountability for program execution and created a tendency in some SYSCOMS to view the laboratories as third parties, no longer entitled to the support and allegiance granted in their former symbiotic relationship. At the same time, the third side of the triangle, the CNM-DNL/DLP, lacked sufficient involvement in day-to-day program management and funding to act as strong laboratory sponsors.

Some of these changes were clearly motivated by the desire to raise the laboratories in the organizational hierarchy. Ironically, however, that objective was being simultaneously negated as each change superimposed a new layer in the management chain. Furthermore, the changes in the laboratory management complex, per se, were accompanied and influenced by still other modifications in the Navy R&D organization (see Part I), which also multiplied staffs between the R&D laboratories and SECNAV and contributed to the diffusion of authority.

The organizational changes of the sixties brought about a significant transition in the management relationships between R&D laboratories and headquarter offices. The laboratories had been granted their own civilian ombudsman; they had been theoretically, at least, elevated in the hierarchy, no longer subjugated to the bureaus' absolute control. But the price of change was a diffusion of formerly simple and direct lines of responsibility, authority, and communication which bred chronic confusion and complexity with attendant delays and disruptions in the R&D process.

THE DEVELOPMENT OF CORPORATE CENTERS OF EXCELLENCE

Associated with the basic and pervasive evolution in the laboratories management relationships, summarized above, was a corresponding trend toward general-purpose laboratories and centers of excellence. The transfer of the 15 major R&D laboratories to

CNM in 1966 was the point of departure for an OSD-inspired effort to consolidate them into large weapons systems centers with missions encompassing a broad spectrum of technical expertise.

The effort was simultaneously driven by technological realities and increasingly complex systems, for any one of which several laboratories might have overlapping or interrelated missions. Even NRL, the Navy's corporate research laboratory since 1946, showed increasing percentages of funding from categories other than research (by 1973 about one-third of its funding was in development projects). This was indicative of a more general trend toward diversification and involvement in systems development throughout the R&D laboratory complex.

The creation of centers of excellence was also supported in the Navy by other initiatives. Various steps were taken in the area of funding, for example, to provide greater flexibility, independence, and businesslike operations. To these ends, blocks of discretionary funds were established for the laboratory directors to pursue "core" programs in Research and Exploratory Development. In 1969, the laboratories were converted to the Navy Industrial Fund system to ensure equal distribution of overhead costs, an accrual acounting system, and a working capital fund.

Latter-day attempts to permit management by fiscal controls rather than manpower ceilings were tested in a department-wide experiment known as Project REFLEX. While both military and outside reviewers believed it was a success, REFLEX was never extended on a permanent basis. A serious attempt was also made to assign more challenging tasks to the centers, including management of entire development programs. This effort also failed to mature due to resistance by those at headquarters with material responsibilities, the real need for management skills beyond technical expertise, and reluctance on the part of some laboratories to become bogged down in the administrative details of program management.

By 1973, however, the trend toward creating weapons systems centers, which would be responsive on a Navy-wide basis, had been firmly established, and the 15 CNM laboratories had been converted to nine RDT&E centers.

COMMENTARY

Even viewed from the perspective of three decades, it was almost impossible to determine the ultimate impact of the postwar evolutionary changes on the Navy RDT&E activities' overall effectiveness. Of the myriad studies and reviews of the defense in-house laboratories over the entire period, none had developed a means of accurately measuring laboratories' effectiveness in the R&D process. Interviews with top-level participants in

the Navy R&D management community amply confirmed the disadvantages of the absence of such a tool. Opinions as to the net impact of the changes on the laboratories varied from one end of the spectrum to the other, reflecting quite frequently the individual's own position in the organization.

There was some general agreement, however, that the diffusion of authority and expansion of the bureaucracy violated earlier, sound principles of R&D management. Both the laboratories and the SYSCOMS viewed the increased layering as a perpetuation of many who exerted influence without accountability. Furthermore, the legions of managers and reviewers caused delays, disruptions, and diversion of RDT&E resources to less productive coordination, review, and procedural tasks. Their stewardship of Navy RDT&E activities also focused increasingly on details of resources and discrete segments of program, at the expense of careful scrutiny of the substance and long-term impact of the overall program.

Nevertheless, it was also accepted almost as a truism by many participants in the R&D process that dynamic, effective research and development, especially at the laboratory level, was typically achieved in spite of the system whatever it was. Despite frequent disruptions on the organizational front, the Navy R&D laboratories enjoyed a generally high level of technical competence. The laboratories' scientists and engineers established and sustained viable working relationships with their counterparts at headquarters over the years. These technical teams made considerable contributions to Navy capabilities. By the end of the era, there was also some evidence to suggest a deepening trend toward more flexibility and authority at the laboratory level.

PART III

R&D PROGRAM PLANNING

Part III addresses the R&D program planning process through which the Navy Department determined requirements, formulated programs, and presented them to appropriate authorities for approval subject to the availability of funds. The actual funding of programs was a function of the financial budgeting and appropriation processes which are discussed in Part IV.

By the end of the era, virtually all levels of R&D management in the Navy Department were devoting substantial time and energy to planning programs and justifying them to appropriate authorities within a highly stylized framework of formal procedures—a method of operation that was largely a post-World War II phenomenon. Prior to the war, there had been little need for such procedures; R&D expenditures were relatively modest, and authority for planning and executing programs was effectively delegated to the material bureaus. During the war, management methods remained simple and direct, although R&D expenditures increased dramatically. The bureaus worked closely with the COMINCH/CNO staffs to identify fleet needs, and when combat experience showed defects or areas where improvements were needed, the COMINCH Readiness Division promptly resolved the matter with the cognizant bureau. While Operational Requirements for new equipment were addressed in official correspondence as the need dictated, there is no evidence that a formal R&D program planning system existed or that either the CNO or COMINCH staffs attempted a comprehensive documentation of all R&D requirements. A degree of intradepartmental coordination was provided through the wartime Naval Research and Development Board, but this body was primarily concerned with promoting effective liaison with the Office of Scientific Research and other outside agencies, rather than reviewing and approving bureau programs, per se.

The postwar formalization of R&D program planning closely followed the development of specialized staff organizations for R&D management described in Part I. Layers of staffs and reviewing authorities grew as pressures mounted in Congress and the Executive Branch to minimize alleged duplication and improve return on defense R&D investments. People appointed to these positions sought administrative mechanisms to help them fulfill their assigned responsibilities, and the bureaucracy became increasingly preoccupied with procedures and documentation to regulate the R&D decisionmaking process. This trend and its relationship to the organizational changes described earlier, are discernible in the following chapters which trace the evolution of R&D program planning in the Navy Department in three successive periods: 1946-1958, 1958-1962, and 1962-1973.

CHAPTER 9

THE R&D PLANNING PROCESS 1946 - 1958

At the beginning of the era, R&D planning procedures were still relatively informal and unstructured. Requirements statements were generated in OPNAV by warfare desks and the Operational Readiness Division based on analyses of intelligence estimates, contacts and correspondence with fleet personnel, and dialogue with the technical community. These requirements were passed by internal memoranda to the Office of the DCNO (Logistics) who then directed establishment of projects in the appropriate bureaus and offices, where the principal responsibility for program planning resided.

In July 1946, the CNO established a Temporary New Development Board to provide him with recommendations on which development programs should be submitted for inclusion in the FY48 budget. Its work completed, the Board was dissolved after 4 months of operation. A more permanent arrangement in the form of the Navy Research and Development Review Board emerged about a year later, closely following the creation of the Research and Development Board in the Office of the Secretary of Defense.

In January 1948, the CNO established a new planning system in which Planning Objectives and Operational Requirements for all equipment to be developed were to be prepared in a uniform manner under the guidance of the Research and Development Review Board.[1] The system and the process it governed are described in the following section.

THE R&D PLANNING SYSTEM OF 1948

The planning system, established in 1948 and implemented during the following 2 years, served the Navy for over a decade. While noteworthy changes were introduced from time to time commencing in 1953, the basic process remained substantially intact until 1962 when a new system was instituted. The process of planning and justifying R&D programs was finally documented in an OPNAV Instruction in 1951.[2] This process is depicted in Exhibit III-1.

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Determining R&D Requirements

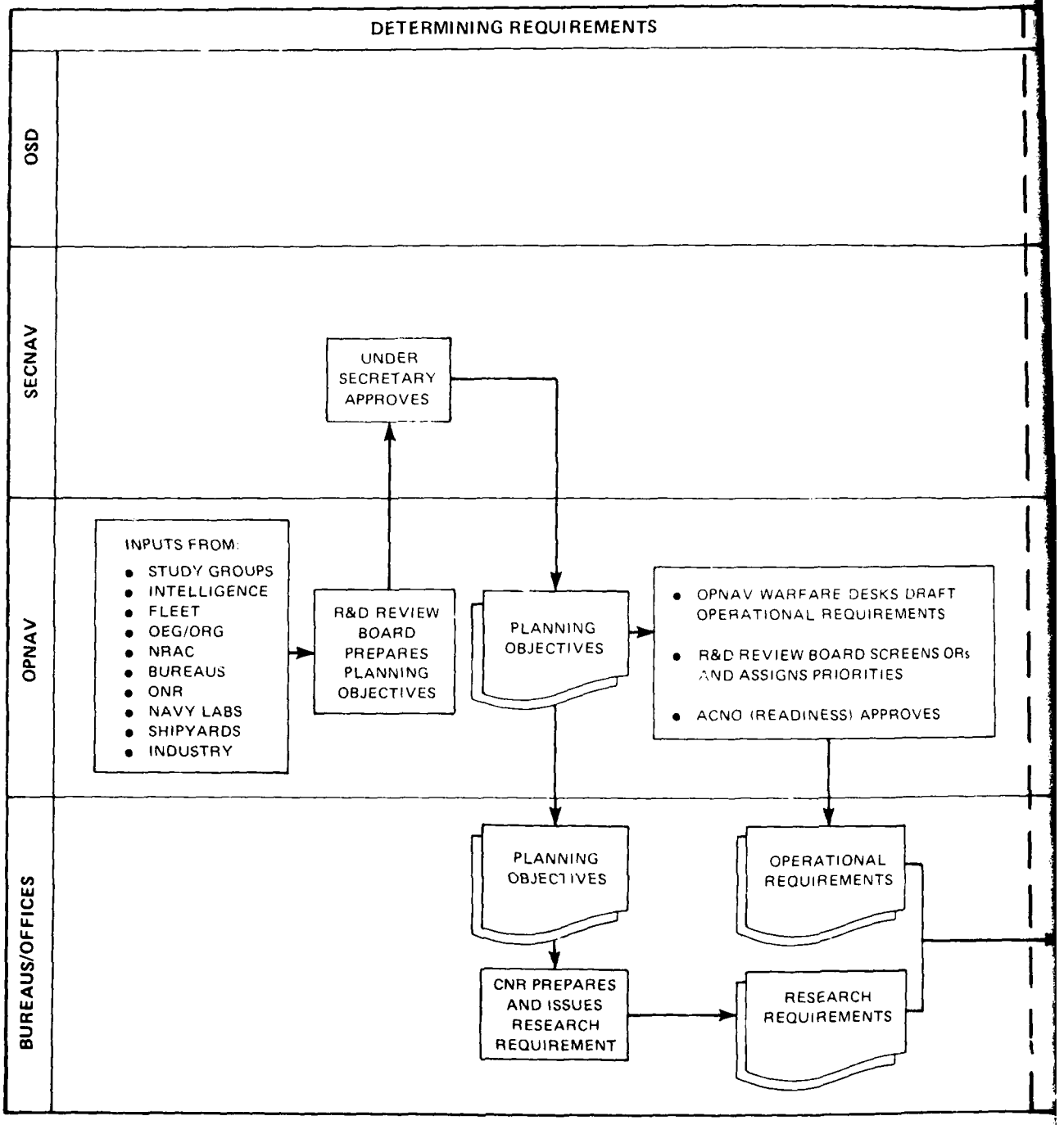
The planning system incorporated the following three basic types of requirements documents, samples of which are included in Appendix B:

- *Planning Objectives* were defined as "statements in broad terms, of a scientific or operational problem which must be met or a function to be performed in the future, which may require new scientific knowledge or the development of new equipment."[3] The system provided for 15 planning objectives that conformed to the "program categories" adopted by the Research and Development Board. It is not clear whether the Navy or the Research and Development Board originated these categories, but it is likely they were the product of a consultation between the staffs involved. Thirteen of the Planning Objectives covered specific mission/logistic areas, one addressed basic research, and the other supporting research. The latter was directed primarily at applied research which did not fit conveniently in any of the other 14 Planning Objectives.

- *Operational Requirements* were the principal documents in which the Office of the Chief of Naval Operations defined the need for development of fleet equipment. An Operational Requirement was defined as "a statement in broad terms, of the estimated operational performances which should be attained in a specific system or equipment designed to solve as a whole or in part, an operational problem stated or implied in a Planning Objective."[4] As indicated in Exhibit III-2, Operational Requirements were designed to fall within the context of RDB Technical Objectives which served to identify the principal types of equipment and functions that were relevant to each Planning Objective. Planning Objectives, Technical Objectives, and Operational Requirements were related through the numbering system illustrated therein.

- *Research Requirements* were defined as "statements in general terms of the estimated need for scientific knowledge in the broad field of the physical, psychological, sociological, and earth sciences which should be attained in order to provide better guidance and support to the Navy's Research and Development Program."[5] They were issued by the Chief of Naval Research in support of the Basic Research Planning Objective.

Responsibility for formulating Planning Objectives resided in the Navy Research and Development Review Board. Once prepared and staffed in consultation with the appropriate bureaus and offices, they were reviewed by the Board and submitted via the Chief of Naval Operations for the approval of the Under Secretary of the Navy.



SOURCE: PREPARED BY BOOZ, ALLEN & HAMILTON INC.

EXHIBIT III-1
R&D Program Planning and Justification Process 1951

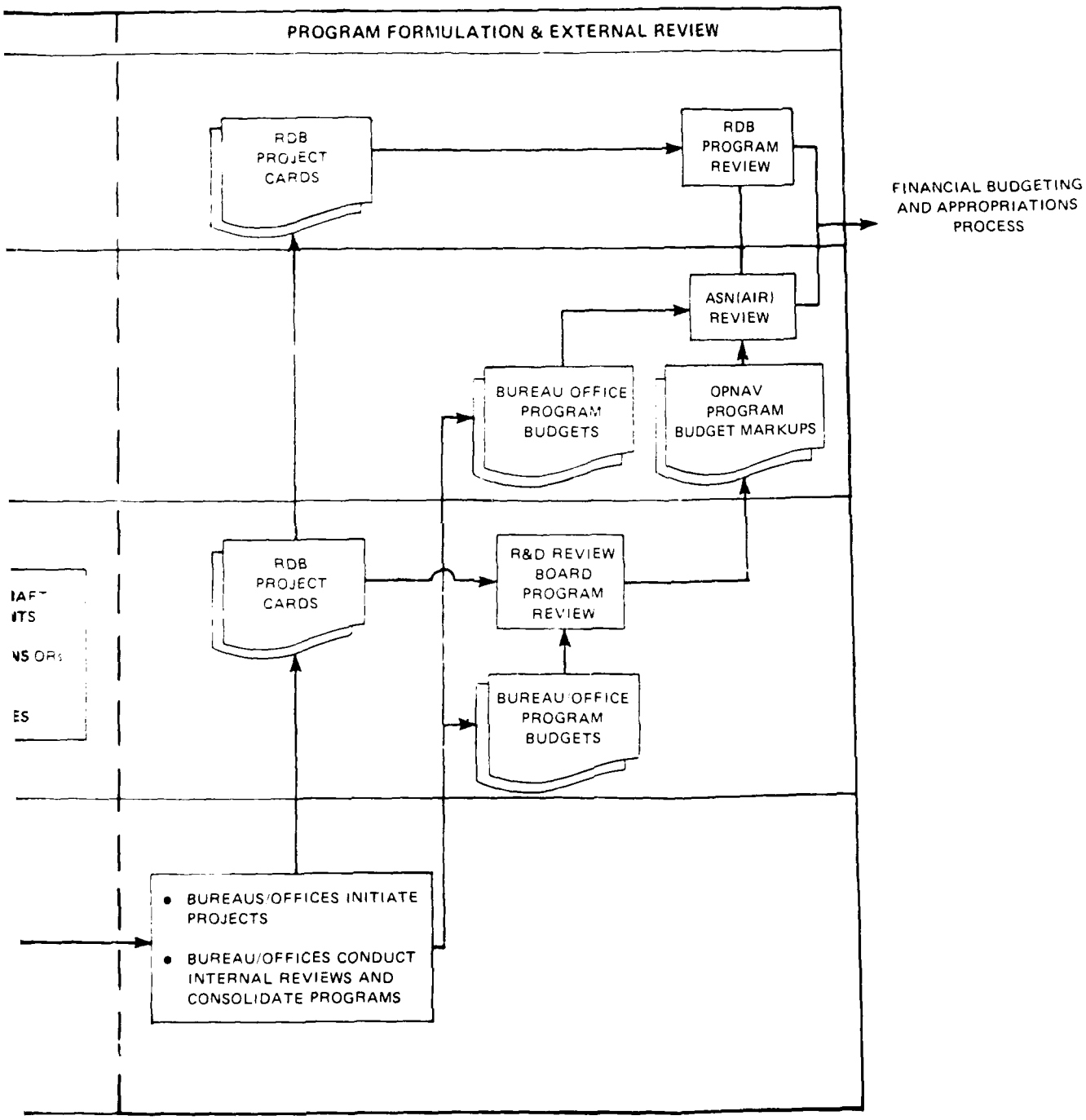
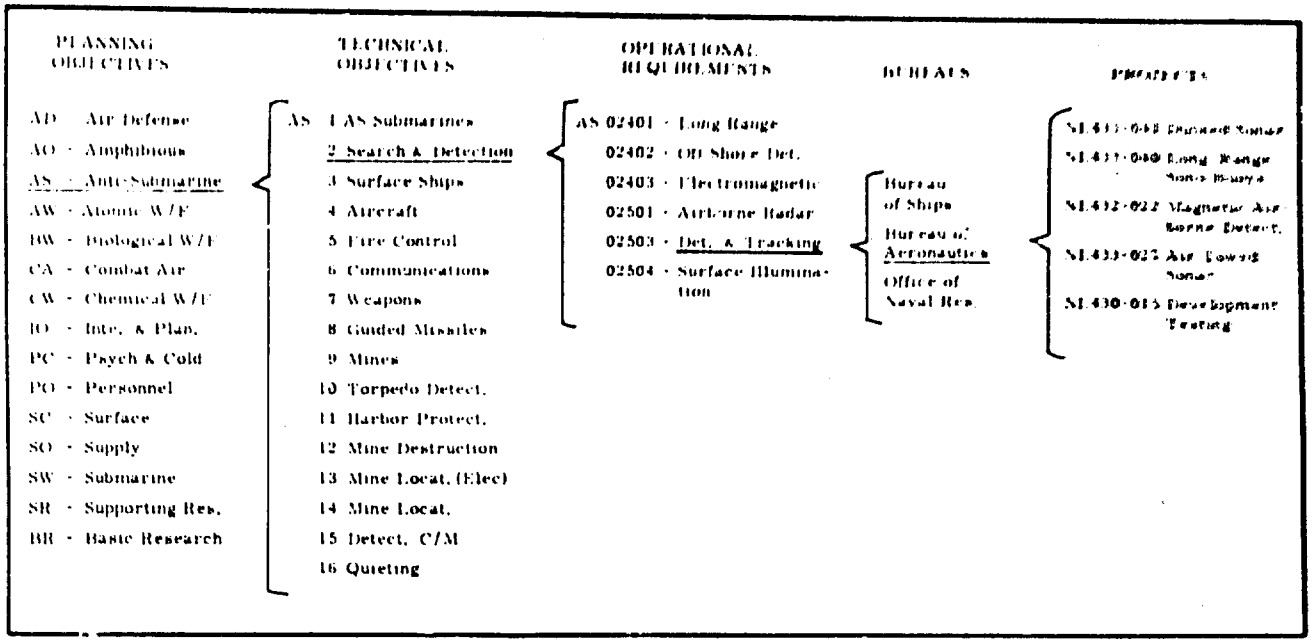


EXHIBIT III-2
Relationship Among Requirements, Documents, and Projects



Source: Based on OPNAV Instruction 0390.1, Coordination of Research and Development, May 25, 1951.

Responsibilities for preparing, approving, and issuing Operational Requirements were assigned to those divisions in the Office of the Chief of Naval Operations that were represented on the Navy Research and Development Review Board (see Exhibit III-3).

As indicated in Exhibit III-1, the planning system recognized the need to base requirements on inputs from all possible sources to ensure that they reflected not only what was needed but also what was technically achievable in the time frame considered, which was specified in each individual requirement. Navy bureaus and offices participated in the generation of requirements through direct liaison with OPNAV and through representation on study groups. Moreover, it was not unusual for initial drafts of Operational Requirements to originate in the cognizant bureau or office and to be refined through iterative discussions between bureau and OPNAV personnel. By the time they were issued, most Operational Requirements represented a reasonable consensus of the key members of the operational and technical communities in the Navy Department.

From 1948 to 1950 there was clearly an intensive effort to implement the new planning system. By 1950 the 15 Planning Objectives had been approved and issued. By 1951, over 200 Operational Requirements were in effect. Thereafter, the documents were updated periodically, and new ones were issued as the need arose.

EXHIBIT III-3
Responsibilities for Operational Requirements in OPNAV 1951

Requirement Area	Requirement Formulation	Priority Allocation	Approval	Promulgation
Air Defense & General	OP-34 OP-37	NRDRB	OP-03D	OP-37
Aircraft	OP-05 (OP-55)	NRDRB	OP-03D	OP-37
Guided Missiles	OP-05 (OP-51)	NRDRB	OP-03D	OP-37
Atomic Energy	OP-36	NRDRB	OP-03D	OP-37
Undersea Warfare	OP-31	NRDRB	OP-03D	OP-37
Primary Interest MarCorps	MarCorps	NRDRB	MarCorps	MarCorps

Legend:

OP-03D	Assistant Chief of Naval Operations (Readiness)	OP-37	New Development and Operational Evaluation Division
OP-31	Undersea Warfare Division	OP-05	Deputy Chief of Naval Operations (Air)
OP-34	Fleet Readiness Division	OP-51	Guided Missile Division
OP-36	Atomic Energy Division	OP-55	Air Warfare Division

Source: Based on OPNAV Instruction 0390.1, Coordination of Research and Development, May 25, 1951.

Formulating the Navy R&D Program

The Navy policy relevant to program formulation was reflected in the 1951 Instruction as follows:

> . . . Research and development programs are planned by the Chiefs of the Bureaus and Offices to contribute to the fulfillment of planning objectives and operational requirements. An essential feature of this system is the freedom of the Bureaus and Offices to *initiate* any and all research and development projects which they consider necessary in light of their assigned responsibilities and the guidance furnished

them, in order to insure consideration of all potentially valuable approaches. Decisions as to which of these projects so initiated will be *prosecuted*, and what level of effort, is made by the Chiefs of the Bureaus and Offices subject to any specific direction by the Chief of Naval Operations and budgetary considerations.

Research and development projects are approved "by the Department" and "by proper authority" when they are approved by the Chief of the Bureau of Office concerned. Information concerning research and development projects, after such approval, is furnished on prescribed forms to the Chief of Naval Operations and to other interested agencies of the Department of Defense to provide a basis for review and coordination of programs. This procedure occurs as far in advance (up to two years) of the start of actual work on a project as practicable. The Navy has maintained, however, that no cumbersome procedures be set up in connection with such review, which would prevent the Chief of a Bureau or Office from undertaking work on a research and development project at any time, with or without review, if he considers it necessary to provide for optimum fleet readiness within his area of responsibility, in support of an operational requirement, and within the limitations of funds available and any specific direction from the Chief of Naval Operations.[6]

Clearly, formulating programs (subject to CNO's right to veto on an exception basis) was a fundamental responsibility of the respective bureaus and offices where technical personnel maintained a continuing dialogue with their counterparts in Navy laboratories, educational institutions, and industry. This dialogue resulted in a variety of proposals for basic/supporting research and for the development of components, subsystems, and major end items such as radars, sonars, aircraft, and guided missiles. It was a function of the cognizant technical personnel in the bureau to screen these proposals and to identify suitable projects and tasks. If especially meritorious, these projects and tasks could be initiated with minimum delay by reprogramming funds previously allocated to the bureau or office concerned. If action could be deferred, they were placed on "shopping lists" which were subject to repeated internal reviews as bureaus and offices prepared their annual program budget requests. As noted above, projects were approved "by the Chief of the Bureau or Office concerned." However, most of the internal review of proposed projects was carried out at the assistant chief level and below.

Once approved, projects were documented in the "prescribed forms" for the information of the Navy Research and Development Review Board, the Defense Research and Development Board, and other interested agencies. Because of the importance that program documentation assumed in later years, the nature of these "prescribed forms" in the early period is of some interest.

The need for an R&D reporting system was addressed in the First Report of the Secretary of Defense in 1948. In discussing the Research and Development Board, the report stated:

> In order that it may have an adequate background against which to prepare overall plans and to review the programs, facility and project proposals of the military departments, the RDB has found it necessary to accumulate a large amount of data which had never before been centralized. . .[7]

Presumably in response to this perceived need for detailed information, the Board adopted a report form known as the Research and Development Project Card which had originated in the Joint Research and Development Board in 1947.

In describing the Navy requirement for program reporting, the OPNAV Instruction stated:

> Present RDB requirements for PROJECT information largely dictate the nature of the minimum report required by agencies outside the cognizant bureau. Provision is made, however, for reporting by units larger than projects without unduly increasing the work involved in making up the report, both to make the information more useful for Navy departmental coordination and to endeavor to prove to the RDB the worth of a broader unit of reporting.[8]

The implication is clear that regular reporting at the project level was imposed over the objections of the Office of the Chief of Naval Operations. Nevertheless, the reporting system, as finally established, accommodated the RDB point of view and consisted of the following reports:

- *Planning Objective Summary*: This report provided brief summary information concerning the broad program of the bureau and offices under the Planning Objectives for the Navy Research and Development Review Board and higher authorities. No specific format was prescribed. One summary was required yearly for each Planning Objective under which a bureau conducted research and development.

- *Operational Requirement Summary:* This report provided summary information or, at least, index information concerning the specific programs (and/or projects) of the bureaus and offices under the Operational Requirements, for the Navy Research and Development Review Board. No specific format was prescribed. One summary was required yearly for each Operational Requirement under which a bureau conducted research and development.

- *Project Description:* This report was required to meet RDB requirements for basic project information and to supplement Operational Requirement Summary submissions. It was submitted on the prescribed RDB form for each new "project" within 45 days after approval, as far in advance of commencement of actual work as practicable, but at least prior to the first regular budget or planned obligation submission.

- *Project Progress:* This report was also required to meet RDB requirements for project information and to supplement Operation Requirement Summary submissions, if necessary. It was submitted annually to update the Project Description described above.

- *Project Status:* This bimonthly report was required by the RDB to report change in status for any projects completed, canceled, suspended, reopened, or superseded during the preceding period. This report was also used to make minor corrections to Project Description submissions.[9]

The lack of enthusiasm of the Office of the Chief of Naval Operations for formal reporting on the project level was probably due to a reluctance to impose additional reporting requirements and to a lack of sympathy for detailed reporting at the OSD level. In addition, needed information was readily available to cognizant OPNAV project sponsors, through other means. By virtue of their close working relationship with bureau personnel, they had ready access to working plans which were more informative than any stereotyped reporting system. While this direct liaison was by no means as easily achieved after the Offices of the Secretary of the Navy and the Chief of Naval Operations were moved from the Main Navy Building on Constitution Avenue to the Pentagon in 1947, updated information on project plans was usually as close as the nearest telephone. In any event, formal project reports rarely sufficed for program decisionmaking. Special project listings and face-to-face discussions with the responsible people were required for this purpose, which was accomplished during the last phase of Navy program formulation, the program budget review.

Although Operational Requirements were assigned "priority classifications" when they were issued, these classifications were of limited utility in determining which projects should be funded. As a practical matter, OPNAV priorities were finally

determined as a function of the annual program budget review. The Navy Research and Development Review Board provided the principal forum for this review in which the bureaus and offices competed for their respective shares of available resources. The Board met with representatives of each bureau and office in turn. OPNAV sponsors, who had a stake in seeing that their requirements were fulfilled, attended meetings on matters under their purview. The review generally concentrated on development projects which were described by bureau representatives, followed by brief roundtable discussions. Most issues were resolved informally. Those that could not be so resolved were referred to higher authority. Supporting research received considerably less attention than development projects, while basic research received little or no review in these sessions.

Upon completion of the program budget review, the Board recommended to the Office of Budgets and Reports the budget allocation for each bureau, ONR, and the Marine Corps for R&D direct costs for each fiscal year. In addition, it examined the allocation of funds among projects proposed by the respective bureaus and offices and submitted a coordinated program budget for approval of the Chief of Naval Operations and the Under Secretary of the Navy.

While the Assistant Secretary for Air was clearly delegated responsibility for correlating and programming research and development activities, persons interviewed did not recall any formal program review at his level. They did recall, however, that the level of interest in research and development displayed by ASN(Air) varied substantially among the incumbents of that office. They also noted that the policy of management by exception was prevalent during the period. Trust of subordinates to resolve most issues while referring to the Assistant Secretary only those matters that required his attention was implicit in that policy.

Research and Development Board Coordination and Review

As indicated in Chapter 2, from 1947 until Reorganization Plan Six was implemented in mid-1953, the Research and Development Board provided the principal forum for reviewing and coordinating research and development programs in the Department of Defense. Operating through some 15 committees subdivided into panels and working groups, the Board sought to fulfill its mission through detailed presentation of programs by the respective Services and related discussions of project plans. The principal purpose of these reviews was to determine whether the programs fit into a coherent plan consistent with military objectives, technical considerations, and priorities; whether all parts of the plan were adequately covered by programs; and whether undesirable duplication existed.[10] Toward this end the project reporting system, described earlier, was set up, and reviews of individual projects and programs were conducted on a continuing basis by the various committees and panels.

The RDB gradually increased its influence over the program budget. In 1949 the Chairman recommended to the Secretary of Defense a budget for FY51 research and development which he considered to be within realistic financial limits and based on carefully considered estimates of the military importance and technical feasibility of specific projects.[11] Thereafter, the RDB conducted an annual review of the Navy R&D program after it had been approved by the Secretary of the Navy. Recommendations resulting from this review were provided to the OSD Comptroller for use in his markup of the DOD financial budget.[12]

Review by the Bureau of the Budget and Congress

While justification of the Navy Department budget was the overall responsibility of the Secretary of the Navy, he relied heavily on the Chief of Naval Research and the bureau chiefs to justify their respective programs directly to the Bureau of the Budget and to Congress. Reviews by the Bureau of the Budget, conducted during successive fiscal years, yielded a high degree of familiarity by its staff concerning the program content. Consequently, such reviews transcended the purely financial considerations discussed later in Chapter 12. The same was true with congressional reviews. Although the depth to which congressional committees examined program content varied considerably, individual congressmen sometimes became very knowledgeable about certain projects and followed their progress with interest. The general atmosphere of a friendly jury prevailed, however, so long as the program appeared to be consistent with the national interest. Despite the increasing intensity of RDB reviews, both the Bureau of the Budget and Congress continued to seek information directly from those responsible for executing the programs.

NOTEWORTHY CHANGES 1953 - 1958

Implementation of Reorganization Plan Six in 1953 was an important milestone in the trend toward centralized control of R&D in the Department of Defense. It also coincided with an emerging awareness of the importance of the systems approach in the development of military hardware. In the years that followed, the disciplines of system analysis and operations research were used with increasing frequency to assess the relative merit of alternatives and to define desired system characteristics. Senior staffs became more and more insistent on documenting these characteristics and plans to achieve them as a prerequisite to program approval. The paragraphs below summarize the principal changes in the R&D program planning process during this period.

Introduction of Development Characteristics 1953

Experience with the planning system of 1948 revealed that Operational Requirements, while useful in providing general direction to development projects, failed in an important respect. On one hand, it was desirable to issue them as soon as a need was perceived, and there was reasonable assurance that a solution was technically possible. On the other hand, it was desired that the requirements documentation reflect as specifically as possible the performance to be sought in specific projects. The latter objective frequently required considerable experimental and/or analytical work to determine the characteristics that were feasible. Moreover, the various bureaus and offices usually identified several promising methods to fulfill an Operational Requirement, either partially or in its entirety, and could establish projects in support of these approaches as they saw fit without first seeking concurrence of the Chief of Naval Operations concerning the specific characteristics of equipment being developed. The rationale for adding Development Characteristics to the planning system and the policy governing their issuance was reflected in an OPNAV Instruction in 1953 as follows:

> Operational Requirements cover many operational, technical, and scientific fields. Some of these fields are limited in that by their nature they point to a specific avenue of approach in the solution to an Operational Requirement. Other areas are very broad and have many avenues of approach and an unlimited number of end items that could contribute a partial solution to the Operational Requirement. It is in these broad areas that a need exists for guidelines. To satisfy this need and to afford the CNO an opportunity to give added guidance to the developing agencies, Development Characteristics may be formulated. These should be confined to operational features. The issuance of Development Characteristics is not mandatory and will seldom be needed. Development Characteristics are subject to addition, deletion, or alteration, during the development process. They should be reviewed periodically. Revision of the Development Characteristics usually will be effected after conferences attended by representatives of the planning agencies, the cognizant bureau and the laboratory or research agency. Guided by Development Characteristics and in support of Operational Requirements, the Chiefs of the Bureaus and Offices initiate and administer projects.[13]

Although moderate in its tone, the introduction of Development Characteristics was the first step of several in a trend toward formalizing the "contract" between the "users," represented by the Office of the Chief of Naval Operations, and the "producers," represented by the material bureaus and the Office of Naval Research. In the years that

followed, the issuance of a Development Characteristic became a prominent milestone in full-scale development projects and one that occasionally delayed initiation of projects until a meeting of the minds could be established between the "users" and the "producers." The format for Development Characteristics is presented in Appendix B.

Increasing Role of the Office of the Secretary of Defense in R&D Decisionmaking 1953-1958

As noted earlier, Reorganization Plan Six resulted in the creation of the Office of the Assistant Secretary of Defense (Research and Development). While the planning and executing of R&D programs was still recognized as the prime responsibility of the military departments, this office exercised much more control over program budgets than the RDB which had operated generally without authority.

Procedures for program budget review involved the Secretary's Research and Development Policy Council and coordinating committees, described in Chapter 2. The Council established guidelines for preparation of a new budget about 18 months in advance of the beginning of the fiscal year in question. Six to twelve months later, the coordinating committees reviewed departmental budget proposals. These same committees reviewed departmental plans for obligating funds after Congress had appropriated them. If the members of a committee arrived at a unanimous view, they were responsible within their respective departments for the execution of that department's share of the program through appropriate channels. In case of disagreement within the committee, the matter was referred to the Assistant Secretary of Defense (R&D) for decision.[14]

While the Assistant Secretary of Defense (R&D) imposed no significant new requirements or detailed procedures for planning and documenting research and development programs, there can be little doubt that the trend toward centralized control, which his office represented, was at least partially responsible for steps taken in the Navy from 1953 to 1958 to effect tighter coordination and control of research and development. Although these actions were generally taken in response to internal management studies such as the Gates Committee and the Libby Board, the members of these groups were sensitive to the need to establish counterparts to the developing staff of the Office of the Secretary of Defense. The Navy's Research and Development Committee, the Assistant Chief of Naval Operations (R&D), the Office of the Development Coordinator, and the Lead Bureau Concept are examples of organizational and procedural measures initiated in this manner. Once created, the new offices initiated changes that are described below.

Introduction of the Technical Development Plan

The Assistant Chief of Naval Operations (R&D) and the Development Coordinator in the Office of Naval Research were both very much involved in the planning process. Dr. Robert Burns, who had been appointed Development Coordinator, intended to apply the emerging system analysis discipline to the coordination of development projects for the following purposes:

- Assessing operational effectiveness of naval warfare systems
- Determining what component(s) placed greatest restrictions on operational effectiveness of a system
- Recommending changes in development programs to provide continuing, progressive, and significant improvements in overall effectiveness.[15]

He had an overriding desire to attain mutual advance agreements on what, why, when, and to whom propositions were being made so that a rational decision system would be self-evident.

Because such analyses supported the responsibilities assigned the ACNO(R&D) who had a limited staff and because the idea of a Development Coordinator in the Office of Naval Research was meeting with little acceptance by the material bureaus (see Chapter 3), these two elements of the R&D organization had a mutuality of interest. The staffs worked together on planning problems. Two products of the Office of the Development Coordinator survived this period. One was a catalogue of technology, classifying it according to functional areas such as surveillance, weaponry, and communications as a basis for assessing the adequacy of the overall program of applied research. This later evolved into a set of Exploratory Development Requirements discussed in the next chapter. The second product was the concept of a Technical Development Plan (TDP) which was viewed by the Development Coordinator as a simple device to encourage the bureaus to "think things through" and present pertinent information for review before embarking on a new project so that complete mutual understanding by all parties was attained before a final decision to invest funds was made.

The Chief of Naval Operations officially adopted the TDP as a part of the planning system in an Instruction issued in 1957.[16] The Instruction stated that such a plan would be prepared in response to an Operational Requirement and reviewed along with the "accompanying technical recommendations of the Chief of Naval Research. . . by the OPNAV office preparing the parent Operational Requirement. . ." It provided brief instructions for preparing the plan (Appendix B) and stated that Technical Development Plans would be accompanied by a proposed Development Characteristic. Thus, for the

first time the bureaus were required to provide formal documentation not only on what they proposed to accomplish but also on how they planned to accomplish it before a Development Characteristic was issued.

CNO Weapon (Support) System Concepts

The 1957 Instruction also directed that cognizant divisions in the Office of the Chief of Naval Operations were to prepare Weapon (Support) System Concepts within the scope of the Navy Long-Range Research and Development Plan which comprised the Planning Objectives described previously. These Concepts were to "express in general physical terms, new systems and system complexes. . . required for support of the Long-Range Objectives and Navy Strategic Planning." They were to be submitted to the Office of the ACNO(R&D) for review and coordination. Upon approval of these broad concepts by the Chief of Naval Operations, the responsible OPNAV divison was to prepare supporting Operational Requirements.

The requirement for the formulation of Weapon (Support) System Concepts represented a need perceived by R&D planners to visualize the types of systems that might be both needed and achievable in the long term. This perceived need was also reflected in internal bureau planning processes of the period. In the mid-1950's both BuAer and BuOrd developed comprehensive long-range plans in which future concepts were projected. These were used as a basis for presentations to OPNAV as well as to Navy R&D field activities.

Members of the CNO staff devoted considerable effort to the generation of system concepts in response to the 1957 directive, but the idea was never fully implemented. While the requirement for OPNAV Weapon (Support) System Concepts was reflected in OPNAV directives in 1958, it failed to reappear thereafter. Nevertheless, the perceived need for technology forecasting and documentation of advanced system concepts in R&D planning persisted as indicated in Chapter 11.

Annual Guidelines

In addition to the Technical Development Plan and the Weapon (Support) System Concepts, the 1957 Instruction provided for the ACNO(R&D) to issue annual guidelines for the preparation and review of the Department of the Navy Research and Development Program. These were, in effect, the Navy counterpart to the ASD(R&D) guidelines mentioned earlier. They were replaced less than a year later by Annual Program Objectives, described briefly below.

Revised Navy R&D Policies and Procedures of 1958

After the reporting senior of ACNO(R&D) had been changed from the DCNO (Fleet Operations and Readiness) to the Vice Chief of Naval Operations, both SECNAV and CNO issued comprehensive instructions updating policies and planning/control procedures for the Navy R&D program.[17] Together these instructions introduced the following changes:

- Research and Development Planning Objectives were to be based, in part, on technical information submitted by the bureaus and offices, consolidated and evaluated by CNR and forwarded to the CNO. ACNO(R&D) was assigned responsibility for preparing Research and Development Planning Objectives in support of the Navy Long-Range Objectives and Navy Strategic Planning. This was accomplished with the assistance of responsible OPNAV Divisions, ONR, and the Commandant of the Marine Corps. ACNO(R&D) was also assigned responsibility for preparing System Concepts based on the Planning Objectives approved by CNO. System Concepts were to be considered in deriving Operational Requirements.

- The Navy Long-Range Research and Development Plan was defined as comprising the aggregate of approved Research and Development Planning Objectives, System Concepts, and Naval Research Requirements. It was to be updated annually by the ACNO(R&D).

- Procedures for preparation of Operational Requirements were defined. A mechanism was provided for agencies outside of OPNAV to submit proposed Operational Requirements.

- Bureaus and offices were authorized to initiate planning in response to Operational Requirements, but development could not commence until CNO had approved a TDP and issued a Development Characteristic. The ACNO(R&D) was assigned authority to approve TDPs after coordination with all responsible OPNAV divisions and to designate an OPNAV Project Officer. In addition, ACNO(R&D)'s approval was required for Development Characteristics prepared by cognizant OPNAV divisions in response to approved TDPs.

- Annual Program Objectives were specified as the initial step in the formulation of the annual research and development program and budget. Prepared by CNO and approved by SECNAV, these objectives were "expressions of reasonably attainable goals planned for accomplishment during a particular fiscal year."[18] They were promulgated to all offices of the Navy Department as a basis for budgetary estimates. The instructions briefly described the process for

formulating the research and development budget, including its preparation by the developing agencies in response to CNO's annual program objectives, its consolidation by ONR, its review in OPNAV, its approval by CNO and SECNAV, and the apportionment of appropriated funds.

- ACNO(R&D)'s role as the OPNAV program sponsor for the appropriation "Research and Development, Navy" was defined. In this capacity he was responsible for presenting the program through annual review procedures described by CNO, SECNAV, and higher authority.

The planning and justification process reflected in the 1958 instructions is depicted in Exhibit III-4. A comparison with Figure III-1 reveals that Requirements for System (Support) Concepts, Technical Development Plans, and Development Characteristics had been superimposed over the basic framework introduced in the planning system of 1948. Annual Program Objectives now guided the formulation of program budgets. Many of the functions of the Research and Development Review Board had been assumed by the ACNO(R&D), and the role of the Board appeared to be gradually diminishing.

According to Dr. Burns, the changes described above were "generally motivated by a desire to institute a form of management by objectives–by a desire to arrive, in advance, at mutual agreement on what was to be done during a specified time period, by whom it was to be done, what performance capability was to be achieved, and at what cost." However commendable this goal, Burns was quick to point out that it was rarely achieved in actual practice.

Notes to Chapter 9

1. Chief of Naval Operations, *Annual Report, 1948* (Washington, 1949), p. 24.
2. OPNAV Instruction 0390.1, Subject: Coordination of Research and Development, May 25, 1951.
3. Ibid, Section 5, p. 2.
4. Ibid.
5. Ibid.
6. Ibid, Section 1, p. 2.
7. Secretary of Defense, *Annual Report, 1947-48* (Washington, 1948), Appendix C, p. 125.
8. OPNAV Instruction 0390.1, May 25, 1951, Section 6, p. 2.
9. Ibid, Section 6, pp. 4-6.
10. Secretary of Defense, *Annual Report, 1947-48* (Washington, 1948), Appendix C, pp. 124-125.
11. Secretary of Defense, *Semiannual Report, July 1 - December 31, 1949* (Washington, 1950), p. 75.

12. OPNAV Instruction 0390.1, May 25, 1951, Section 9, p. 2.

13. OPNAV Instruction 3910.1, Subject: Navy R&D Planning, May 20, 1953.

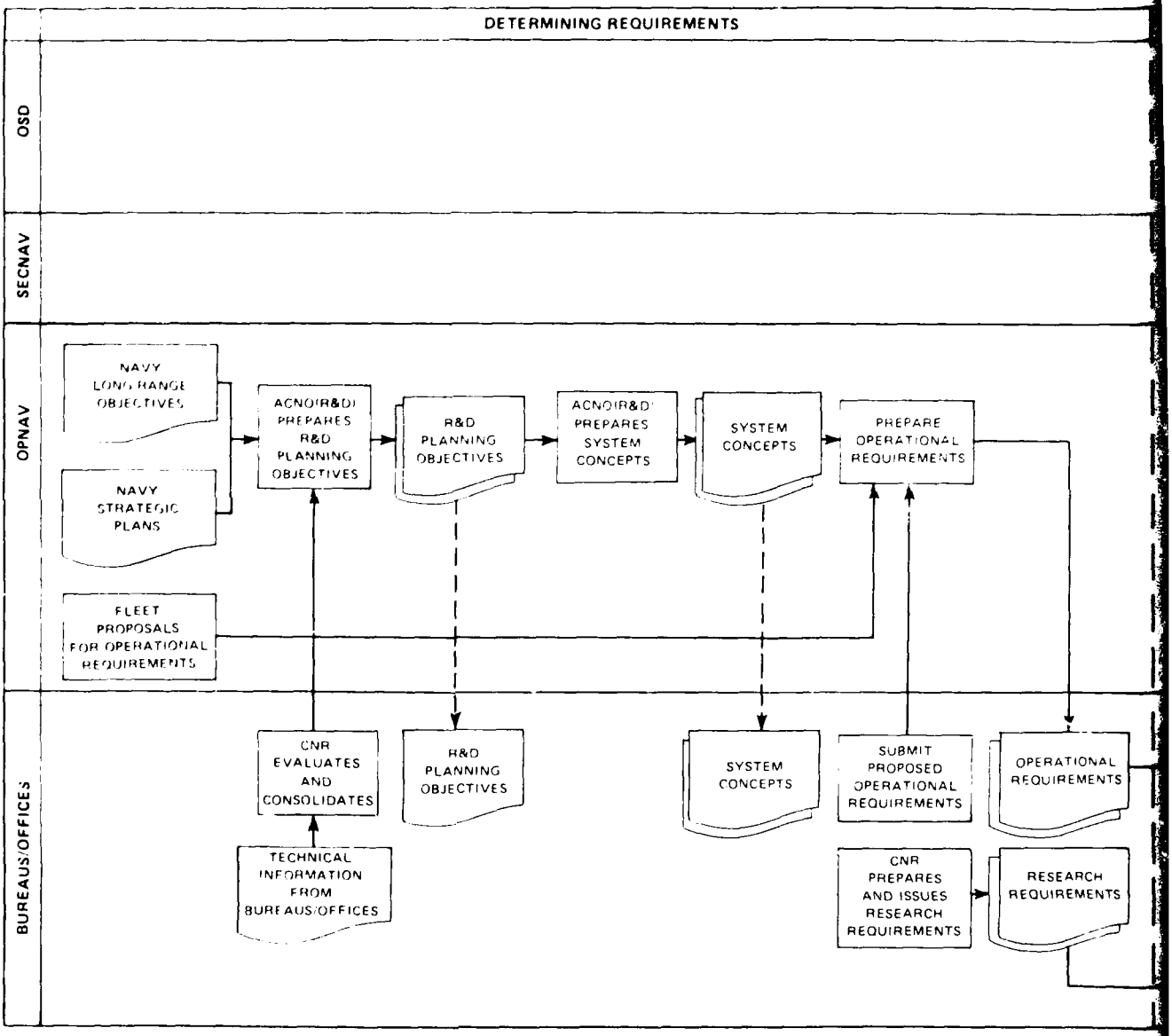
14. Commission on Organization of the Executive Branch of the Government, *Subcommittee Report on Research Activities in the Department of Defense and Related Agencies* (Washington, 1955), p. 13.

Stanley Marcus, "Communications System for Office of Development Coordinator, Office of Naval Research" (Unpublished Masters Thesis, The George Washington University, 1958), p. 7.

16. OPNAV Instruction 3910.2, Subject: Navy R&D Planning and Management Procedures, November 5, 1957.

17. SECNAV Instruction 3900.7, Subject: Research and Development Policies, April 10, 1958; OPNAV Instruction 3900.8, Subject: Planning and Control Procedures for the Navy R&D Program, April 29, 1958.

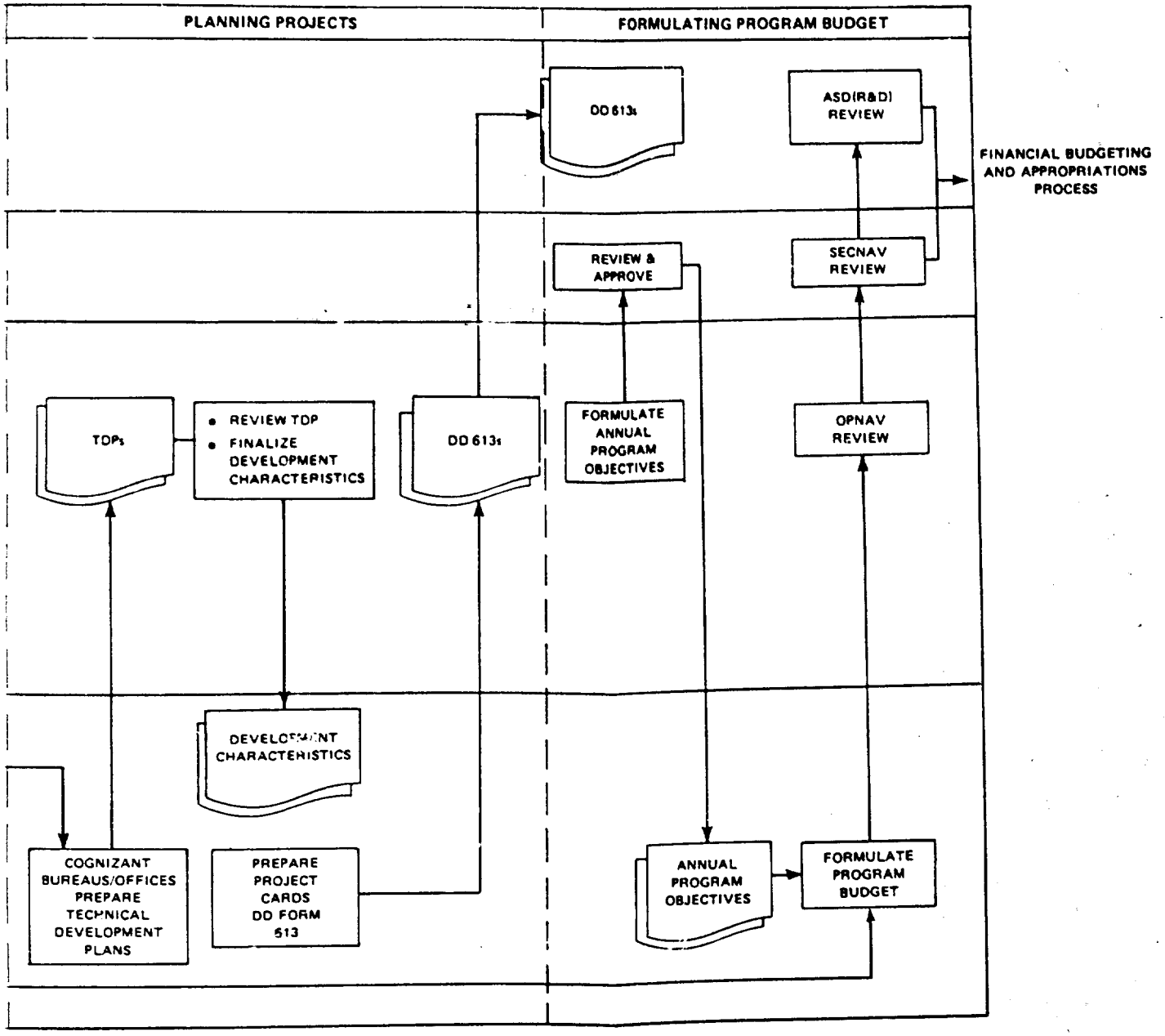
18. SECNAV Instruction 3900.7, April 10, 1958.



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EXHIBIT III-4

R&D Program Planning and Justification Process 1958



CHAPTER 10

NEW CONCEPTS IN PLANNING AND PROGRAMMING 1958-1962

The creation of the offices of the Director, Defense Research and Engineering, Assistant Secretary of the Navy (Research and Development), and Deputy Chief of Naval Operations (Development), set the stage for revolutionary changes in the way research and development programs were to be planned and justified during the following decade.

The period from 1958 to 1962 was largely a period of transition during which these newly established offices formulated policies and procedures to fulfill their assigned responsibilities. During this 4-year period, several new concepts in R&D planning and programming were introduced. They are described briefly in the sections below.

ESTABLISHING THE EXPLORATORY DEVELOPMENT CATEGORY

The Navy's planning system of 1948 had recognized the appropriate difference in the techniques for planning research and development projects depending on the character of the effort involved. Separate Planning Objectives were established for basic and supporting research, and Research Requirements assumed a different character from Operational Requirements which guided hardware development. Thus, the concept of an R&D spectrum with basic research on the one end and full-scale development on the other was inherent in the procedures of the first decade.

Because it fell under the overall control of the Chief of Naval Research, the Naval Research Program was clearly distinguishable from the remainder of the R&D effort in budgets and planning documentation. However, the remainder of the R&D program was comprised not only of full-scale development but also of substantial effort that could not be so classified. The latter was loosely labeled "technology programs" and comprised projects more clearly focused on end-products than research but entailing a higher level of uncertainty and lower financial commitment than full-scale development. Technology programs covered a wide variety of efforts, ranging from applied research in components and subsystems to fairly sophisticated experimental hardware. These programs were the ones to which the Office of the Development Coordinator directed much of its attention in cataloguing work according to its functional relevance in order to analyze and appraise it more effectively.

In 1959, the distinction between the above segments of the R&D program–research, technology, and full-scale development–was reflected for the first time in the Navy's FY61 RDT&E program budget which was structured in three parts: Part I - Systems, Part IIA - Exploratory Development, and Part IIB - Naval Research.[1]

In the new three-part structure, Naval Research and Systems projects both retained the requirements/project numbering systems that were traceable to the Navy's planning system of 1948. To provide a means of classifying effort under Exploratory Development (Part IIA), the DCNO(Dev) adopted the functional areas devised earlier in the Office of the Development Coordinator. This classification scheme was reflected in a set of Exploratory Development Requirements, issued by DCNO(Dev) in 1959 and updated in 1962. The requirements were defined as "statements of the need for investigations and studies to demonstrate new techniques in naval functional areas, or the feasibility of a system, subsystem or component."[2] The 1962 directive established 171 project areas in 17 functional groupings (see Exhibit III-5).

Bureaus and offices were authorized to establish projects in each of these areas relevant to their assigned responsibilities. Projects so established could be compared with those of other bureaus, since they carried the same title and requirements number. Project listings and project reports (see below) were required to be structured accordingly. For the first time, senior staffs in the Department of the Navy and the Office of the Secretary of Defense had a viable framework for scrutinizing exploratory development effort and the funds allocated to support it.

EXHIBIT III-5
Exploratory Development
Functional Areas 1962

F001	Target Surveillance	F010	Jamming and Deception
F002	Navigation	F011	Naval Defense Applications
F003	Environmental Surveillance	F012	Aircraft and Aircraft Support
F004	Integrated Surveillance	F013	Ships and Submarines
F005	Command Control	F014	Boats and Amphibious Vehicles
F006	Communications	F015	Logistics
F007	Data Processing	F016	Personnel Administration
F008	Weapons and Ordnance	F017	Training
F009	Guided Missiles		

CHANGES INTRODUCED BY OSD

The development of new management systems was accelerated by the change in administrations resulting from the 1960 elections, after which Robert McNamara assumed the position of Secretary of Defense and Harold Brown became the Director of Defense Research and Engineering. Most relevant in the context of this chapter were the introduction of a new Department of Defense system for planning, programming, and budgeting; further restructuring of the RDT&E program; and more comprehensive DDR&E reporting requirements.

Planning, Programming, and Budgeting System

The Planning, Programming, and Budgeting System (PPBS) was introduced by Charles Hitch, Assistant Secretary of Defense (Comptroller), in July 1961 for implementation in the FY63 budget. Its major objective was to overcome alleged weaknesses in the existing financial management procedures and to provide a tool for overall direction and control of the defense effort. One aspect of PPBS, discussed further in Part IV of this report, was the concept of "programming" introduced by Hitch to bridge the gap between planning and budgeting. The goal of the programming function was to aggregate the myriad programs and activities of the entire defense establishment, without regard to Service, into meaningful "program elements," e.g., integrated combinations of men, equipment, and installations whose effectiveness could be related to military objectives.

Program elements were further aggregated into major program packages in which all program data, both physical and financial, were projected 5 years ahead and incorporated into a Secretary of Defense-approved "Five Year Force Structure and Financial Program" [later changed to Five Year Defense Plan (FYDP)]. The FYDP represented all approved programs for the next 5 years; however, inclusion in the FYDP did not guarantee that a program would ultimately be funded. "The FYDP," explained Hitch, "is merely a detailed physical and financial tabulation of those programs that have been approved by the Secretary of Defense. . . period. Thus it is only necessary to plan, not to prophesy!"[3]

Continuous updating in the PPBS of plans and funds was effected through the Program Change Control System by which additional reports on significant changes were submitted to and required approval by the Secretary of Defense. A comprehensive annual review of the FYDP was instituted as an additional step in the development of the annual budget estimates. An important offshoot of the PPBS was the restructuring of the RDT&E program into six discrete categories, described below.

The Six RDT&E Categories

After the three-part program structure was introduced in 1959, efforts to refine it continued in the Navy under the guidance of Rear Admiral Charles Martell who had been assigned as Assistant Chief of Naval Operations (Development). When Admiral Martell became Deputy Director of Defense Research and Engineering (Administration and Management) in March 1961, he assumed a key role in the subsequent restructuring of the Defense RDT&E program.

In November 1961, Dr. Harold Brown (DDR&E) addressed a memorandum to the Assistant Secretaries (R&D) of the respective Services and the Assistant Secretary of Defense (Comptroller) in which he noted that introduction of the Program Package Concept had highlighted the problem of the diverse structure of research and development programs of the Services. He considered it necessary to develop consistent, meaningful descriptions of categories of R&D effort to permit use of that concept as a management tool, and he proposed definitions for a five-part program structure.[4] Following coordination with the Services, his proposal emerged intact except for the addition of the sixth category (Operational Systems Development), which was designed to accommodate research and development performed in support of projects assigned to other program packages. The six categories were defined as follows:

- *Category 6.1 - Research*: Includes all effort directed toward increased knowledge of natural phenomena and the environment and efforts directed toward the solution of problems in the physical, behavioral, and social sciences that have no clear, direct military application. It would thus, by definition, include all basic research and, in addition, applied research that is directed toward the expansion of knowledge in various scientific areas. It does not include efforts directed toward proving the feasibility of solutions to problems of immediate military importance or time-oriented investigations and developments. The Research elements are further characterized by using level-of-effort as the principal program control.

- *Category 6.2 - Exploratory Development*: Includes all effort directed toward the solution of specific military problems, short of major development projects. This type of effort may vary from fairly fundamental applied research to quite sophisticated breadboard hardware, study, programming, and planning efforts. It would thus include studies, investigations, and minor development effort. The dominant characteristic of this category of effort is that it be pointed toward specific military problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions and determining their parameters. Program control of the Exploratory Development elements will normally be exercised by general level of effort.

- *Category 6.3 - Advanced Development*: Includes all projects that have moved into the development of hardware for experimental or operational test. It is characterized by line item projects, and program control is exercised on a project basis. A further descriptive characteristic lies in the design of such items being directed toward hardware for test or experimentation as opposed to items designed and engineered for eventual Service use. Examples are VTOL aircraft, Artemis, Experimental Hydrofoil, X-15, and Aerospace Plane Components.

- *Category 6.4 - Engineering Development*: Includes those development programs being engineered for Service use but which have not yet been approved for procurement or operation. For example: Mauler, Typhon, and the B-70. This area is characterized by major line item projects, and program control is exercised by review of individual projects.

- *Category 6.5 - Management and Support*: Includes research and development effort directed toward support of installations or operations required for general research and development use. Included would be test ranges, military construction, maintenance support of laboratories, operations, and maintenance of test aircraft and ships. Costs of laboratory personnel, either in-house or contract-operated, would be assigned to appropriate projects or as a line item in the Research, Exploratory Development, or Advanced Development program areas, as appropriate. Military construction costs directly related to a major development program will be included in the appropriate element.

- *Category 6.6 - Operational Systems Development*: Includes research and development effort directed toward development, engineering, and test of systems, support programs, vehicles, and weapons that have been approved for production and Service employment. This area is included for convenience in considering all RDT&E projects. All items in this area are major line item projects which appear as RDT&E Cost of Weapons Systems Elements in other Programs. Program control will thus be exercised by review of the individual research and development effort in each Weapon System Element.[5]

DDR&E Reporting Requirements

The Office of the Secretary of Defense issued directives in 1960 and 1962 revising its requirements for reporting research, development, and engineering information.[6] The 1960 revision was modest; the 1962 revision more far-reaching. Requirements as they existed after the latter revision are summarized below.

Three types of reports covering the R&D program were specified: RDT&E Project Cards (DD Form 613), Technical Development Plans, and Project Listings. RDT&E Project Cards had evolved from the old RDB form described earlier. Although varying in detail, their concept was not radically different from earlier versions. Submission of Technical Development Plans to OSD, however, was a new requirement. Motivated by the desire for more complete information from all Services on sizable projects, the OSD required 20 copies of the document to be submitted for each RDT&E project included in the Advanced, Engineering, or Operational Systems Development categories except as specifically exempted by DDR&E. Technical Development Plans were to include the following:

- A narrative statement of the requirements, a brief development plan, and statements delineating the performance, reliability, and maintainability characteristics. (Further details on this requirement are presented in Appendix B).

- A graphic presentation of the time scheduling of the development and the milestone schedule that formed the basis for reporting under the Programming System.

- A financial plan for the life of the development, including the planned support from all appropriation sources as contained in the Program Element Summary Data Sheet submitted under the PPBS.

- A statement (if appropriate) from the responsible missile range commander indicating his coordination and his estimate of additional facilities and/or instrumentation required by the range to support the plan.

Project Cards or Technical Development Plans were to be submitted at least once a year for each RDT&E project, when a Program Change was approved, or when other significant changes occurred in the status of an RDT&E project. Although the directive did not specify that DDR&E approval of these reports was required, ability to withhold or defer project funds in case of disagreement was inherent within his authority. The directive also provided instructions on the content of project listings which were required to support budget reviews for future fiscal years (three times a year) and to monitor changes for a current fiscal year (quarterly).

NAVY RDT&E PLANNING SYSTEM OF 1962

Just as the basic features of the planning system of 1948 served the Navy for over a decade, the system established in 1962 remained virtually unchanged during the next

decade. The revised Navy planning system was first described in a directive issued by Vice Admiral John T. Hayward, Deputy Chief of Naval Operations (Development) in 1962.[7] The following year, the directive was replaced by one which clarified definitions and other aspects of the system based on experience and developments in the interim period.[8]

Requirements Documents

With the exception of Naval Research Requirements, which continued to be the responsibility of the Chief of Naval Research, requirements documents were prepared by the cognizant division in the Office of the Chief of Naval Operations in the format prescribed by the DCNO(Dev). After coordination with other DCNOs concerned, the DCNO(Dev) issued the requirement to the appropriate bureaus and offices.

The system incorporated the following types of requirements documents:

- *Planning Objectives (POs)* described the common objectives of Navy functional warfare and support areas under the four major groupings of Strike Warfare, Antisubmarine Warfare, Command Support, and Operational Support.

- *General Operational Requirements (GORs)* were prepared for each functional warfare and support area listed in Exhibit III-6. They described in broad but significant terms the capabilities the Navy needed within the area, stated the estimated threat posed by the forces, both present and projected, of potential enemies, and described the operational requirements needed by naval forces to meet this threat.

- A *Tentative Specific Operational Requirement (TSOR)* stated the need for achieving a particular operational capability and outlined the identifiable characteristics necessary in a warfare system to fulfill the requirement. The TSOR defined the desired performance and provided to the technical bureau as much guidance as possible in order that alternatives and tradeoffs could be considered. It directed the technical bureau to submit a Proposed Technical Approach (PTA) containing one or more recommended methods for developing the system in question.

- A *Specific Operational Requirement (SOR)* stated a need for a particular capability and outlined the system characteristics that describe what capability is to be achieved. The SOR defined the performance throughout the system's operational environment and established the goals for reliability, maintainability, and personnel requirements. The SOR normally resulted from the TSOR-PTA process, but the CNO could promulgate the SOR, eliminating the TSOR step. The bureau was directed by the SOR to submit a Technical Development Plan (TDP).

EXHIBIT III-6
List of General
Operational Requirements

10	**STRIKE WARFARE**	**30**	**COMMAND SUPPORT**
11	Airborne Attack	31	Command Control
12	Surface Attack	32	Naval Communications
13	Submarine Attack	33	Electronic Warfare
14	Amphibious Assault	34	Navigation
15	Vacant	35	Reconnaissance & Surveillance
16	Airborne Anti-Air	36	Intelligence
17	Surface Anti-Air	37	Environmental Systems
18	Submarine Anti-Air	38	Unconventional Warfare
20	**ANTI-SUBMARINE WARFARE**	**40**	**OPERATIONAL SUPPORT**
21	Airborne ASW	41	Logistics and Supply
22	Surface ASW	42	Personnel Protection
23	Submarine ASW	43	Personnel Administration & Training
24	Ocean Surveillance	44	Astronautic Support
25	Mining	45	Aviation Support
26	Mine Countermeasures	46	Ship Support
27	Ship Underwater Defense	47	Ordnance Support
		48	ABC Defense

- An *Advanced Development Objective (ADO)* outlined an experimental system or major component that was not yet assured as to military usefulness, technical feasibility, and financial acceptability. An ADO directed a lead bureau to prepare a TDP to accomplish the objective stated (e.g., conduct a feasibility study, develop an experimental warfare system, or develop R&D test and evaluation equipment).

- *Exploratory Development Requirements (EDRs)* stated the needs for investigations and studies to demonstrate new techniques in naval functional areas, or the feasibility of a system, subsystem, or component. This comprised the effort directed toward improvement and expansion of naval capabilities through application of advances in technology.

- *Naval Research Requirements (NRRs)* were statements, in general terms, of the need for investigations and studies in the physical and life sciences to provide information related to a solution of specific practical problems and to obtain a fuller knowledge or understanding of the subject under study.

Reporting Documents

The revised Navy planning system reflected a significant increase in formal reporting. Under this system, the material bureaus and offices were required to submit the following reports and/or planning documents:

- A *Proposed Technical Approach (PTA)* presented, for the CNO's consideration, one or more methods for achieving a required capability, either in response to a TSOR or voluntarily submitted in direct support of a GOR. The purpose of a PTA was to provide technical analysis of proposed developments, assess the technical risks as well as the cost involved, and recommend methods for accomplishing an objective. Tradeoff options of cost versus time and cost versus performance were to be emphasized.

- A *Technical Development Plan (TDP)* comprised the plan for the fulfillment of an ADO or SOR. It was to include a detailed description of the effort necessary to accomplish the development together with a recommended funding schedule. Approval by the CNO constituted the authority to commence a development project commensurate with funds that were provided by separate action. When funded, the TDP became the primary management control and reporting document for the life of the development project.

- *Project Reports (DD Form 613)* contained the basic program information required by management for the analysis and review of RDT&E projects in the DOD Research and Exploratory Development Categories.

- *Monthly Project Evaluations (MPE)* provided a monthly updating of information contained in the TDP Summary. These reports were expected to reflect the best judgments of the responsible bureau or office of the current status and future prospects for each project in the categories of Advanced Development, Engineering Development, or Operational Systems.

- *Exploratory Development Program Highlights and Hotline Reports* were additional "as occurring" reports reflected in the 1963 directive.[9]

The Program Planning and Justification Process

The process of planning and justifying programs in the early 1960's is broadly depicted in Exhibit III-7. In little over a decade, the number of steps in this process had increased by at least a factor of five. The "user-producer" dialogue, with OPNAV

representing the "users" and the material bureaus and offices representing the "producers," had been transformed into a highly formalized documentation system to serve the accelerated trend toward centralized control of the R&D program. General Operational Requirements addressed much broader subjects than the Operational Requirements had covered. Specific Operational Requirements were more comprehensive and definitive than the Development Characteristics. Proposed Technical Approaches had been established as an additional step in the translation of broad requirements into more specific directives, a role previously performed by the Technical Development Plan.

The process of formulating R&D programs in response to CNO requirements had also changed dramatically. Except in Research and Exploratory Development, the bureaus and offices no longer had virtual "carte blanche" to initiate projects in response to general requirements, subject only to the annual program budget review. Although control over new starts had been gradually tightened over the years, the planning system of 1962 and DOD's Planning, Programming and Budgeting System represented further increases in the degree of control exercised. At the project level, the Technical Development Plan and Project Reports (DD613) represented the plan. Planned projects (or changes to existing projects) were incorporated in the program through Program Change Proposals that required OSD approval. Theoretically, changes could be processed at any time. In practice, they became closely coupled to the budget cycle.

Annually, the Assistant Secretary of the Navy (R&D) issued R&D guidance and instructions for the preparation and submission of the Navy RDT&E program. Based on that guidance and the annual program objectives, the bureaus, offices, and the Marine Corps Headquarters prepared their portion of the program and forwarded it to the Chief of Naval Operations via the Chief of Naval Research. Representatives of the Commandant of the Marine Corps and the Chief of Naval Research participated in the OPNAV review after which the consolidated program was submitted to the Assistant Secretary of the Navy (R&D) who convened the Navy Research and Development Committee, as necessary, to assist him in his review. After approval by the Assistant Secretary, the RDT&E program was disseminated to the Chief of Naval Operations, the Commandant of the Marine Corps, the Chief of Naval Research, and the chiefs of the respective bureaus for use in the preparation of the Research, Development, Test, and Evaluation Budget.[10]

By virtue of the programming process, much of the external coordination and review was closely intermeshed with program formulation. The remainder revolved around annual reviews of program budgets as reflected in project listings described earlier. Typical budget review cycles are depicted in Part IV.

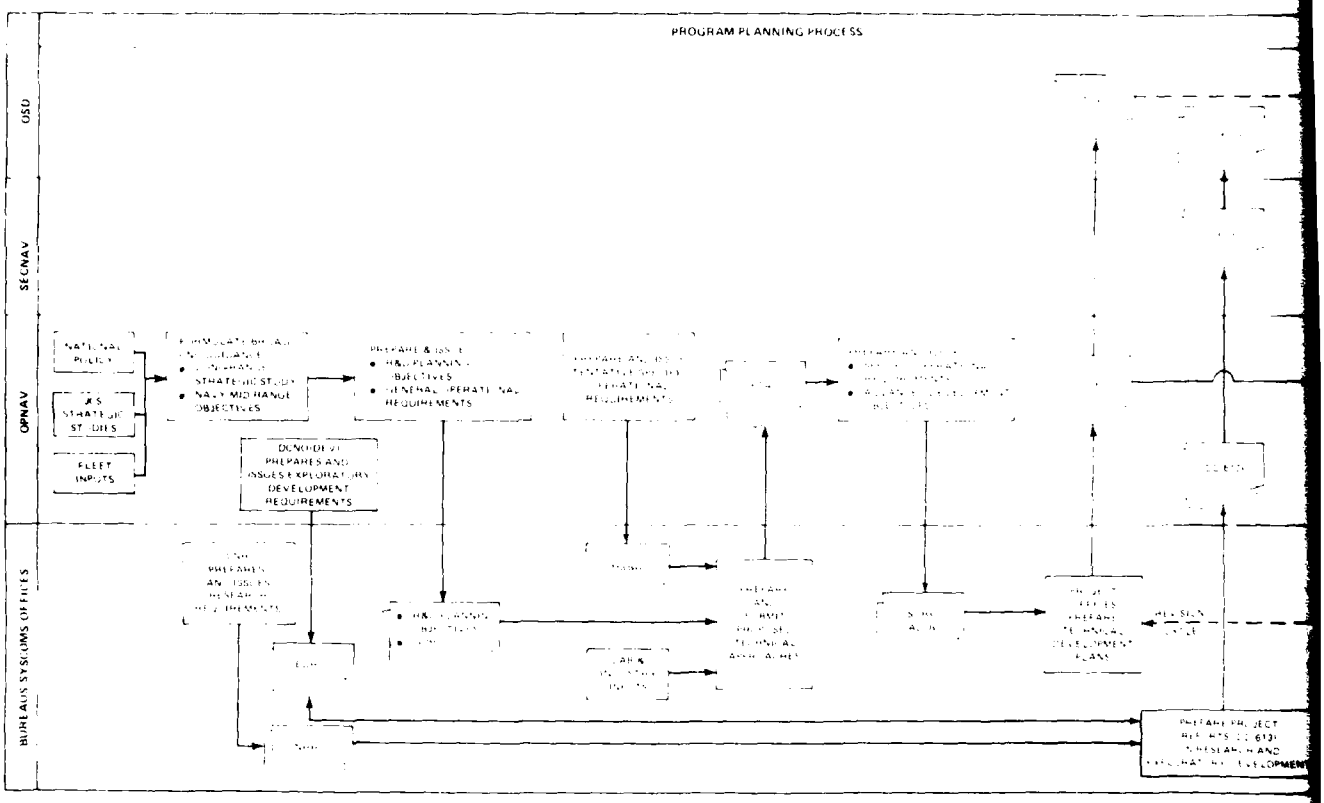
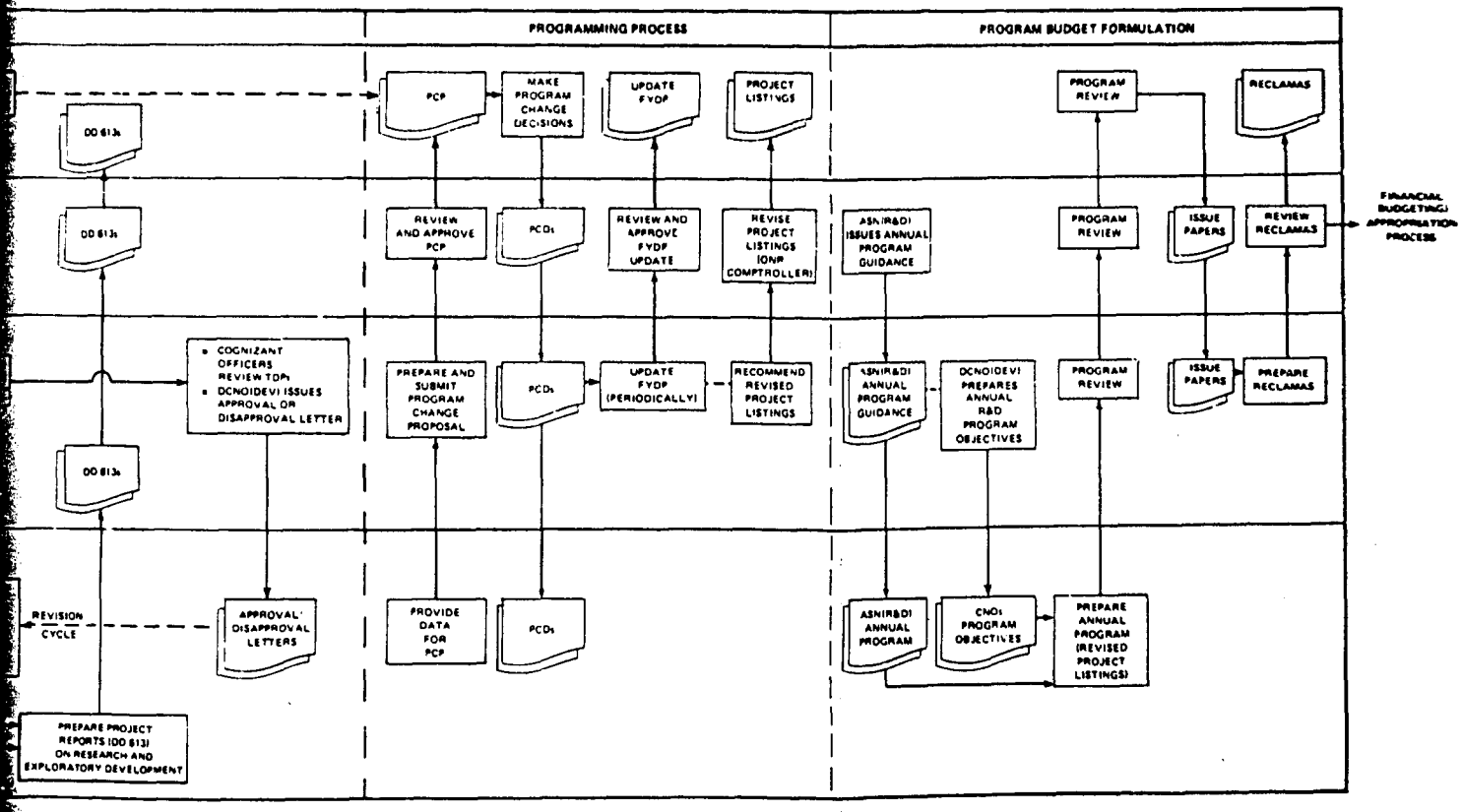

PROGRAM PLANNING PROCESS
OSD
SECNAV
OPNAV
BUREAUS/SYSCOMS/OFFICES
NATIONAL POLICY
JCS STRATEGIC STUDIES
FLEET INPUTS
DEVELOPS AND PREPARES AND ISSUES EXPLORATORY DEVELOPMENT REQUIREMENTS
PREPARES AND ISSUES GENERAL OPERATIONAL REQUIREMENTS
PREPARES AND ISSUES
• NAVY PLANNING OBJECTIVES
• GENERAL OPERATIONAL REQUIREMENTS
PREPARES AND ISSUES
• NAVY MID-RANGE OBJECTIVES
PREPARES AND ISSUES GENERAL OPERATIONAL REQUIREMENTS
PREPARES AND ISSUES
• NAVY PROGRAM OBJECTIVES
• ADVANCED DEVELOPMENT OBJECTIVES
PREPARES AND ISSUES GENERAL OPERATIONAL REQUIREMENTS
PREPARES AND ISSUES GENERAL OPERATIONAL REQUIREMENTS
PREPARES AN ADVANCED DEVELOPMENT PROJECT
PREPARE PROJECT

EXHIBIT III-7
R&D Program Planning and Justification Process in the Early 1960's



Notes to Chapter 10

1. Department of the Navy, *Review of Management of the Department of the Navy, Research and Development Management Study*, Vol. II, Study 3 (Washington, D.C., October 19, 1962), NAVEXOS P-2426-B3, p. 168.

2. OPNAV Instruction 3910.3, Subject: Procedures for Planning, Coordination, Administration, and Reporting of Navy RDT&E Program, March 30, 1959; OPNAV Instruction 3910.3A, Subject: Exploratory Development Requirements, August 21, 1962.

3. "Layman Views the Wonderful World of Hitchcraft," *Armed Forces Management* XIII, No. 12 (September 1967), 71-85.

4. Memorandum, Harold Brown, DDT&E to Service Secretaries, Subject: Structure of Research and Development Programs, November 6, 1961.

5. DOD Instruction 3200.6, Subject: Reporting of Research, Development, and Engineering Program Information, June 7, 1962, Enclosure 3.

6. DOD Instruction 3200.6, Subject: Reporting of Research and Engineering Program Information, March 1, 1960; DOD Instruction 3200.6, Subject: Reporting of Research, Development and Engineering Program Information, June 7, 1962.

7. OPNAV Instruction 3900.8A, Subject: Planning and Control Procedures for the Navy R&D Program, January 15, 1962.

8. OPNAV Instruction 3900.8B, Subject: Planning and Control Procedures for the Navy R&D Program, September 16, 1963.

9. ibid.

10. SECNAV Instruction 3900.7A, Subject: Research and Development Policies, March 1, 1960.

CHAPTER 11

FURTHER DEVELOPMENTS IN PROGRAM PLANNING AND JUSTIFICATION 1962-1973

In terms of its impact on the R&D program planning process, the six-part program structure was one of the most fundamental and pervasive of the changes introduced in the early 1960's. While the distinction between research, technology programs, and full-scale development had long been implicit in the way the Navy Department planned and executed its R&D programs, the classification of projects, per se, had not been a matter of great concern. It was left almost entirely to the discretion of the material bureaus and offices. The six-part structure, however, touched off a new preoccupation with the classification of R&D effort at all levels. It not only changed the way the program budget was presented but also provided a foundation upon which other changes were built.

The Director, Defense Research and Engineering reflected his approach to program control in the definitions of the four principal categories. Research and Exploratory Development were to be controlled on a general level-of-effort basis with decisions on individual projects delegated to appropriate managers in the military departments. OSD control of Advanced and Engineering Development, on the other hand, was to be exercised at the project level. Since these projects generally involved substantial investments and downstream implications, decisions were to be reserved for higher levels of management.

As organizational specialization along program category lines increased in the 1960's, compartmentalization of the RDT&E program became more pronounced. This trend is evident in the sections below which summarize developments in the program planning and justification process from 1962 to 1973 for each of the four principal RDT&E program categories.

PLANNING AND JUSTIFYING NAVAL RESEARCH

Historically, planning the Naval Research Program involved establishing an appropriate balance in the level of effort expended by the various scientific and engineering disciplines identified in Naval Research Requirements. The proposed work was described in the prescribed project cards and justified by the Chief of Naval Research in the various internal and external reviews described earlier. Both ONR and the bureaus had substantial freedom to reprogram funds within the broad areas for which they were apportioned. Consequently, fine tuning of the basic plan was accomplished as a function of the program execution process discussed in Chapters 15 and 17.

The basic procedures for planning and justifying the Naval Research Program changed very little during the period. The role of the Chief of Naval Research had been well established, and research management policies were consistent with the level-of-effort philosophy adopted for that category. The Research Requirements, initially reflected in the planning system of 1948, continued in use. Prior to 1964, there were 11 such requirements (see Exhibit III-8).

EXHIBIT III-8
Naval Research Requirements (NRR)

R001	Chemical Sciences	R007	Material Sciences
R002	Physical Sciences	R008	Electronic Sciences
R003	Mathematical Sciences	R009	Engineering Mechanics
R004	Earth Sciences	R010	Energy Conversion
R005	Biological Sciences	R011	General Science
R006	Psychological Sciences		

Despite its relative stability, the program was not immune to high-level scrutiny during the period. In 1963, Dr. Harold Brown, the DDR&E, initiated an OSD review of the Research category with the avowed intention of strengthening its management. This resulted in the establishment of the Joint Advisory Committees (JAC) by the DDR&E in 1964. These committees were designed to support a Defense Committee on Research (DECOR) that was composed of the chief scientists of the three military departments. The action resulted in the creation of two research program elements, Defense Research Sciences and In-House Independent Laboratory Research. The Defense Research Sciences element was further subdivided into 14 subelements[1] (Exhibit III-9).* This set the stage for consistency in reporting across Service lines and presumably facilitated DDR&E examination of interservice efforts.

EXHIBIT III-9
Naval Research Program Elements and Subelements 1964-1973

General Physics	Energy Conversion
Nuclear Physics	Oceanography
Chemistry	Terrestrial Sciences
Mathematical Sciences	Atmospheric Sciences
Electronics	Astronomy and Astrophysics
Materials	Biological and Medical Sciences
Mechanics	Behavioral and Social Sciences

* Note: Naval Research Requirements were subsequently revised to parallel this subelement structure.

The above actions initiated a series of events over the following 10 years that increased the role of DDR&E in the planning of research and required the Navy to focus on this function to a greater degree. Although a level-of-effort budgeting philosophy had generally prevailed during the period, attempts were continuously being made to adjust the total and the distribution within this total. In response to pressures from DDR&E for more formal planning procedures, the CNR established subelement monitors in 1967 who were responsible for meeting with their Navy colleagues, as well as those from the Army and Air Force, to prepare more definitive plans and procedures for justifying the programs.

In November 1969 Congress passed the Military Procurement Authorization Act of 1970 in which it incorporated a provision known as the Mansfield Amendment which stated:

> None of the funds authorized by this Act may be used to carry out any research project or study unless such project or study has a direct and apparent relationship to a specific military function or operation.[2]

This provision touched off an intensive review of the Naval Research Program in which the Chief of Naval Research personally examined over 4000 tasks totaling over $120 million. Among these he found approximately $4 million—less than 3.5%-which could be open to question in the context of a literal interpretation of the amendment.[3] This provision was softened somewhat in the Military Procurement Authorization Act of 1971, allowing more freedom for the Secretary of Defense to interpret the potential relationship of research to military functions and operations. While the Mansfield Amendments initiated a flurry of interest in examining the relevance of research, their impact on the Naval Research Program was minimal.

PLANNING AND JUSTIFYING EXPLORATORY DEVELOPMENT

When it was first established in 1959, the Navy's Exploratory Development category was, in fact, a program of miscellany for that work that did not fit either in Naval Research or Systems Development. It was loosely defined as including "the correction of deficiencies to in-service equipment and the development of new system components and techniques (not associated with a system development) with emphasis on the advancement of capability for future generations of fleet systems."[4] While the reference to corrections of deficiencies to in-service equipment was removed in subsequent definitions, patterns had already been established which took years to change. Thus, the "3-T (Terrier, Tartar, and Talos) get-well program" was funded under Category 6.2 until it

threatened to engulf the entire guided missile technology program element. At that time it was transferred to Category 6.6 along with the funds supporting it. A comprehensive program to alleviate electromagnetic hazards to ordnance followed a similar pattern, as did several others. Moreover, small hardware development continued to be carried to completion under Exploratory Development. Because these projects and those directed toward correction of defects in existing fleet equipments were generally in response to real and pressing needs, they were often accorded higher priority than the relatively nebulous long-term technology efforts.

Although primary responsibility for planning and executing Exploratory Development projects was clearly vested in the material bureaus and offices, the DCNO(Dev) staff assumed an active coordinating role. Officers on this staff were designated as program element coordinators to review program content, prepare justification documents, monitor progress on projects of special interest, and serve as principal points of contact for the DDR&E on assigned program elements. This assignment was in addition to their regular responsibilities for preparing requirements documents, monitoring system development projects, etc. In addition, the Technical Analysis and Advisory Group in the Office of DCNO(Dev) conducted a continuing appraisal of technology programs, including Exploratory Development. This Group initiated an annual report of its findings, entitled: "Appraisal of the Navy Research and Engineering Program (ANREP)." The practice, however, ran into difficulty because Navy-wide agreement on official criteria for judging the merit of programs could not be achieved. The report was discontinued after the 1964 edition.

As a part of the Dillon Board effort, the Research and Development Management Study identified a number of problems in the management of Exploratory Development. For example, the report stated:

> Perhaps the biggest problem in exploratory development is funding. Since these funds usually are managed by the same people who manage "called-out" systems developments, they serve as a bank account to take care of reprogramming actions incident to overruns in "called-out" systems. . . There is no deliberate and systematic effort to examine the yearly crop of findings in basic research with a view toward immediate or eventual application. Systems are called out for Advanced Development, Engineering Development and Operational Systems Development prematurely, i.e., before all the thinking has been done. There is no financial elbowroom in exploratory development to exploit new ideas in a timely manner.[5]

As noted earlier, the final report of the Dillon Board highlighted the need to "build a fence around Exploratory Development," and recommended that a flag officer be put in charge of the category. It also proposed that the Assistant Secretary of the Navy (Research and Development) take the following actions:

- Develop policy and procedures to establish clearly the position of Exploratory Development in Navy RDT&E effort and to ensure its adequate support
- Establish firm procedural controls over the transition of development effort from the Exploratory Development stage to succeeding stages for major systems and components
- Identify and transfer to Advanced Development or Engineering Development all hardware development projects that meet the definitions of those categories
- Identify and transfer to Engineering Development or System Development all "correction of in-service deficiencies" projects
- Establish management procedures that recognize the competence of the technical bureaus and offices to control the technical details of the Exploratory Development projects
- Develop procedures for the continuous collection, assessment, documentation, and reporting of new ideas and proposals by Navy bureaus and offices.[6]

In the years following his appointment in response to the Dillon Board recommendations, the Chief of Naval Development (CND) worked with the DCNO(Dev) to purify the Exploratory Development Program by transferring effort to other categories where it was more appropriately funded. Also, the CND's position as the Exploratory Development advocate served to dampen the tendency to divert resources from that category to fund deficiencies in other areas. In this sense, the "fence around Exploratory Development" served the purpose for which it was intended.

Other aspects of CND's role were, however, less clear cut. As indicated earlier (PART I), CND's assigned responsibilities included promulgating Exploratory Development Requirements, preparing annual assessments of technology projections, appraising Exploratory Development plans, and making program recommendations to the ASN(R&D). To perform these functions, the CND perceived a need for an integrated planning and programming system which would cope with the diverse and heterogeneous character of the Exploratory Development Program without unduly infringing on the technical management prerogatives of the bureaus and offices. The elements of the CND

system and other developments in the Exploratory Development planning process are discussed in the subsections that follow.

Exploratory Development Goals

The creation of the Exploratory Development category focused attention on what some considered to be a fundamental problem in its management—optimizing the relevance of investments in technology to the projected needs of the fleet. Neither the General Operational Requirements nor the Exploratory Development Requirements issued by OPNAV provided definitive objectives suitable for guiding the multiplicity of projects and tasks in the Exploratory Development Program, nor were they satisfactory as a basis for appraising the relative importance of proposed work. An initial study by Bureau of Naval Weapons (BuWeps) personnel in 1963 pointed up the need for more definitive goals for these purposes. As a result, BuWeps initiated the development of Exploratory Development Goals.

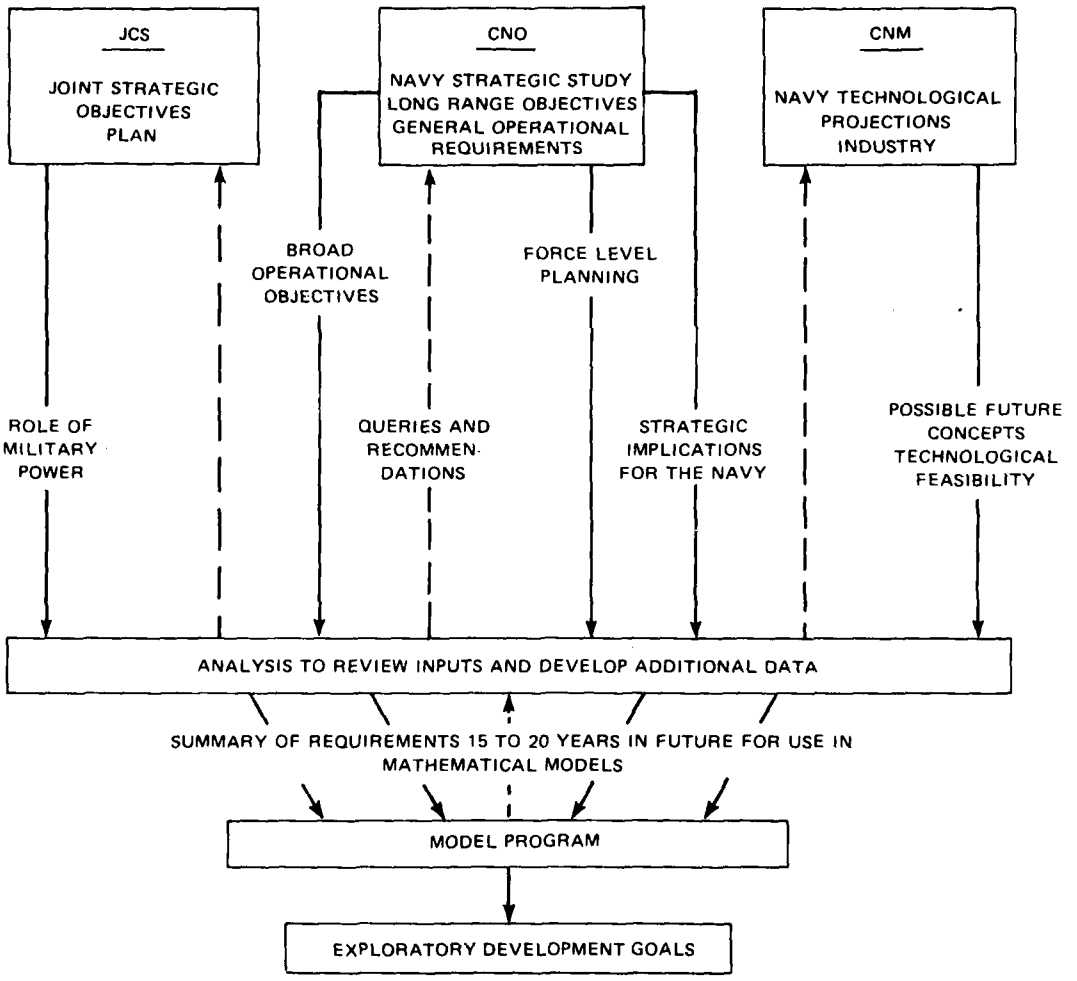
This work was temporarily interrupted by the implementation of the Dillon Board recommendations after which responsibility for generating Exploratory Development Goals (EDGs) was transferred to the DCNM(Dev)/CND as a Navy-wide effort. The basic approach followed by the CND staff was to translate available information on projected force levels, threat, projected technology, and strategy into a form which would provide useful guidance to planners and technologists in the laboratories, bureaus, and offices involved with Exploratory Development. The goals were to be designed to answer questions as to what capability was needed, why it was needed, and when it was needed without foreclosing options of the technologists with respect to their technical approach. The goals had to be significant both to laboratory and program management personnel and consistent with each other. In addition, each stated goal had to be achievable. The approach is depicted in Exhibit III-10.

The total effort took approximately 3 years. Documents entitled "Undersea Target Surveillance," "Air Target Surveillance," "Land and Surface Target Analyses," and "Support Area Analyses" were distributed in 1967. Rationales for each of the four volumes were distributed in 1968.

Despite the considerable number of man-hours invested by the CND staff in their derivation, the EDGs never received sufficient acceptance by either OPNAV or the technical community to make them effective in the role for which they were intended. OPNAV personnel were unwilling to commit themselves to the goals derived through the CND analysis or to participate in establishing priorities for those goals. Lacking such a commitment, CND was able to command little more than passive acceptance by the bureaus and laboratories.[7]

To test their practical utility, the CND initiated tasks in the Naval Undersea R&D Center at San Diego, the Naval Weapons Center at China Lake, and the Navy Ordnance Laboratory at White Oak to examine selected EDGs and derive a methodology for translating them into responsive technology programs. The Naval Ordnance Laboratory developed such a methodology and tested its application but reported a general lack of enthusiasm for the concept by most of the laboratory personnel. As a practical matter, the technical community identified the programs they intended to pursue and then found appropriate EDGs to serve as a justification rather than the other way around.[8] While the EDGs remained in effect for a number of years, they were never updated, and this attempt at "top down" planning of Exploratory Development was finally abandoned.

EXHIBIT III-10
Approach to Derivation of Exploratory Development Goals



SOURCE: OFFICE OF CHIEF OF NAVAL DEVELOPMENT.

The Navy Technology Forecast

Prior to 1965 technology forecasts were normally incorporated in the Navy's strategic studies. The other military departments, however, had followed a different approach. The Army had supported a comprehensive program of technology forecasting for a number of years, while the Air Force's Project Forecast of the early 1960's had been greeted with enthusiasm by DDR&E and others in the defense R&D community.

In May 1965 the Chiefs of Naval Research and Naval Development jointly appointed an ad hoc group to conduct a preliminary survey of the state of the art in technology forecasting and its utility in long-range planning. This developed into a two-phase study* during which forecasting methods used by the other Services, industry, and academic institutions were investigated. In addition, the study group consulted representatives of the principal headquarters agencies involved in research and development (Marine Corps, OPNAV, NAVMAT, ONR, NAVORD, NAVAIR, and NAVSHIPS) who all expressed particular needs for such a forecast. Their report, submitted in May 1966, recommended that a Navy Technology Forecast be organized in three parts as follows:

- *Part I - Scientific Opportunities:* to include projections of research in physical engineering, environmental, and life sciences relevant to future technical capabilities of the Navy.

- *Part II - Technological Capabilities:* to address a broad spectrum of capabilities expected to result from basic technologies to functional subsystems.

- *Part III - Probable Systems Options:* to include examples of systems that might be provided if the capabilities described in Part II were achieved. Each example would be supported by a technical report that described the proposed system concept in terms of parametric characteristics that were derived from an analysis of the several subsystems and components involved in the concept.

These recommendations were implemented over a year later (August 1967) when CND issued detailed procedures for a funded forecasting program that envisioned participation by all Navy RDT&E field activities, systems commands, bureaus, and offices.[9] The first Navy Technological Forecast was published in October 1968. The first edition, however, contained only Parts II and III. Part I was published in October 1969, as were updated versions of the other parts. While Parts I and III consisted of a single volume, Part II included five volumes. Samples of these forecasts are included in Appendix C.

* The second phase of this study was conducted by another group convened by CND in November 1965.

In February 1970, a thorough review of the concept, content, and utility of the Navy Technological Forecast was conducted by a working group assembled by the Office of the Chief of Naval Development. Following this review, new guidelines were prepared and issued that changed the name of the document to Navy Technological Projections and resulted in a reduction in its size by a factor of five.[10]

The Navy Technological Projections were updated annually, in whole or in part, from 1970 to 1973. In 1971, an industry version of Part II was also published. In July 1973, a Workshop on Navy Technological Projections was held at the Naval Weapons Laboratory at Dahlgren under the sponsorship of the Chief of Naval Development. The workshop involved both the "user" and "producer" communities in an attempt to determine the process best suited to meet future Navy needs for Technological Projections. Based on results of this workshop, it was concluded that benefits derived from Parts I and II were not commensurate with resources expended. Accordingly, preparation of these parts was discontinued. Part III was renamed "Advanced Systems Concepts" and its annual publication continued.

It is interesting to note that the Advanced Systems Concepts were analogous, in many respects, to the Weapons (Support) Systems Concepts introduced–but never successfully implemented–by OPNAV in 1957 except that responsibility for their preparation now resided with the systems commands rather than OPNAV. Thus, the Navy Technology Forecast succeeded in reinventing a document that had been eliminated in the planning system of 1962. This could be interpreted as an indication of the merit of such a document, the shortness of the corporate memory, or both.

CND Planning and Programming Procedures

Because his staff was small, the CND had to establish mechanisms within the technical community to assist him. One of the earliest was the concept of the Program Element Administrator (PEA), established in 1966. Program elements represented aggregates of Exploratory Development effort over which DDR&E exercised financial control. They often included projects in which more than one Navy bureau or office participated, and the PEAs were individuals nominated by their parent organizations to serve additional duty on the CND's staff for the purpose of program element coordination. Program Advisory Panels were also established in 1966 to facilitate the coordination of planning, appraisal, and justification of Exploratory Development and Advanced Development efforts in which the financial support transcended program element lines.

While Program Element Administrators and Program Advisory Panels served a useful purpose in facilitating communications, their usefulness in decisionmaking was limited. Three pressing problems required attention. First and foremost was the lack of a

coherent approach to the allocation of Exploratory Development funds. The CND believed he needed a more effective technique of program appraisal and allocation of funds based on relative merit of the proposed work. On the other hand, the CND's charter clearly intended that executing agencies retain a high level of freedom from outside interference.

Any appraisal scheme to help solve the first problem was, however, dependent on the adequacy of information available; therein lay the second problem. Information provided on Research and Technology Resumes (DD Form 1498)–a successor to the RDT&E Project Report (DD Form 613)–was generally vague and incomplete. Definitive objectives were usually lacking, and the relevancy of work to fleet needs was sometimes obscure.[11] The CND was frequently called upon to provide information to others on how much effort was devoted to certain warfare areas, certain areas of technology, etc. There was no way to assemble such information short of an ad hoc manual screening of DD1498s or a call to the systems commands for help, a process which was both disruptive and time consuming.

The third problem was an offshoot of the other two. The Exploratory Development Program structure had become unnecessarily complex and unwieldy. By successive additions over the years, the Exploratory Development Requirements had increased in number. They comprised 193 project areas, many of which were overlapping and confusing, resulting in a cumbersome framework for program appraisal and presentation of information to higher authority.

Against this backdrop, several initiatives were undertaken from 1966 to 1968. They are summarized in the paragraphs that follow.

- *Task Area Plans.* Task areas were subdivisions of projects chosen as the principal unit of Exploratory Development effort which CND would use in its information systems. The concept of Task Area Plans was introduced in February 1967, to provide a basis for CND program review and decision-making, as well as a source of information for higher authority.[12] Each plan was to consist of a Department of Defense Research and Technology Resume (DD Form 1498), a Tentative Funding Profile, and Relevancy Codes. The fundamental principle underlying the Task Area Plan was one of "management by objectives." SYSCOMS, bureaus, and offices were urged to formulate specific, time-oriented objectives at the task area level as a basis for CND appraisal. The retirement of task areas by virtue of their attainment or abandonment was intended to form a visible indicator of the dynamics of the Exploratory Development Program. Funding profiles were to provide a range of funding options. Relevancy Codes were designed to facilitate electronic retrieval of certain information not explicitly identified through the functional

program structure. In practice, however, the concept met with limited success. In the years that followed its introduction and despite substantial effort on the part of the CND staff to promote the concept, the quality of Task Area Plans continued to pose a problem. Originators of these documents were either unwilling or unable to articulate their objectives in writing with sufficient specificity to serve the purpose for which the plan was intended. Nevertheless, the Task Area Plan remained as the principal mechanism for communicating the plans of the executing agencies to CND.

- *Program Appraisal.* In 1967, the CND staff initiated the development of a systematic technique for program appraisal. The approach was to have the cognizant program administrators on the staff derive figures of merit for each task area based on a numerical rating of such factors as military utility, probability of success, financial acceptability, and management considerations. Provision was made to normalize figures of merit so as to minimize bias of individual evaluators. Moreover, since results were aggregated by program element and executing agency in programming the allocation of funds, the technique was purposely intended to be relatively insensitive to individual figures of merit. While rationale for funding changes were disseminated in executing agencies, their freedom to reprogram resources in case of disagreement remained intact.* Although the appraisal technique was modified from time to time and made more qualitative in recognition of the subjective nature of the appraisals, CND's use of formal program appraisal as a basis for allocating Exploratory Development resources continued for the remainder of the era.[13]

- *Program Structure.* In 1967, the CND staff undertook to restructure the program with the avowed purpose of presenting it in more logical terms, eliminating overlap, and reducing the number of project areas. This effort culminated in January 1968 in a revised program structure that classified the effort under five functional groupings: Target Surveillance, Command and Control, Weaponry, Naval Vehicles, and Support Technology.**[14] The revised structure reduced the number of project areas by 50 percent in order to facilitate the appraisal of the program and its presentation to higher authority. Each project was subdivided into subprojects, task areas, tasks, and work units to accommodate the needs of various echelons of management for assignment and reporting of work.

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* The Research and Technology groups in each of the systems commands conducted independent appraisals of their own segments of the Exploratory Development Program as a basis for distributing resources among individual subprojects and task areas.

** In 1967, the Exploratory Development Division was reorganized into branches paralleling the new functional areas.

- *Technology Workshops.* Technology Workshops were convened from time to time to get key members of the community working together in certain areas such as missile propulsion, logistics technology, materials technology, etc. An important element contributing to their effectiveness was the participation of personnel who could ensure effective followup of conclusions reached. Consequently, attendance by key personnel in OPNAV, the office of CND, and the respective bureaus/offices as well as the laboratories was encouraged. The technology workshops proved to be especially effective mechanisms for coordinating programs of mutual interest, with results generally commensurate with the degree of participation.[15]

Justifying Exploratory Development to Higher Authority

Because of the heterogeneity of the work and the multiplicity of tasks, Exploratory Development generally defied centralized planning and control. This was apparently recognized by the OSD policy which initially called for managing this category on a level-of-effort basis. This policy, however, did not deter top-level staffs from attempts at micromanagement. Many delved into program details at the task and work unit level and imposed their own technical judgment on those responsible for planning and executing the programs by deferring funding until agreement was reached. While not without justification in some instances, the practice was generally disruptive and had an adverse impact on program continuity.

To some extent, the Office of the Chief of Naval Development shielded executing agencies from attempts at micromanagement from above by providing a central focal point for information on the Navy's Exploratory Development Program. The CND established lines of communication that permitted the Navy to develop timely, coordinated responses to the many demands from higher authority for program information. The CND staff functioned as the principal negotiators with the DDR&E staff on matters of program content and funding levels. The desired level of confidence in the Navy's management of Exploratory Development was not achieved, however, and the tendency toward micromanagement by the DDR&E staff continued unabated.[16]

Avowedly to facilitate exchange of program information among the Services and thereby permit and encourage more effective delegation to the Services, Dr. Chalmers Sherwin, the Deputy Director for Defense Research and Engineering (Research and Technology) in 1965, introduced the concept of reporting on the Work Unit level. A Work Unit was defined as the lowest subdivision of effort established for internal laboratory management. Such effort was to be reported on DD Form 1498 after work had been initiated. The number of such units in Navy Exploratory Development averaged approximately 5,000 in the last 10 years of the era. To make the information available to

Navy investigators, to reduce unnecessary duplication, and exchange pertinent information, the Navy Automated Research and Development Information System (NARDIS) was established in 1965. The intention was for all Form 1498s to be on file and available for retrieval, using the Defense Documentation Center (DDC) thesaurus. A utilization check was made in 1967 when it was determined that 446 requests were received from the Navy, 115 from the Army, and 5 from the Air Force.

A study in 1968 recommended transfer of NARDIS from CNR management to the CNM to try for more utilization by the laboratory community. Since the Defense Documentation Center established by OSD had also incorporated the DD 1498s into its own storage and retrieval system, the Navy abolished NARDIS in 1971.

Exploratory Development as a Part of the "Technology Base"

In the late 1960's, the term "Technology Base" was introduced by Dr. John Foster, the DDR&E between 1964 and 1972. The term was intended to be descriptive of the background or "homework" required prior to approval of major projects leading to full-scale development. By definition it included Research, Exploratory Development, and early Advanced Development.

While both Research and Exploratory Development were readily identified in this context, early Advanced Development had been subject to quite different management processes. In 1971, however, the Deputy Director for Research and Advanced Technology assumed responsibility for the "Technology Base" programs. Concentrating initially on Research and Exploratory Development, in 1973 he began to assume responsibility for reviewing selected Advanced Development projects as well.

In 1970 DDR&E introduced two new types of documents. They were called Technology Coordinating Papers and Area Coordinating Papers. Prepared at the OSD level, the former provided an overview of the well-defined areas of the "Technology Base," e.g., aircraft propulsion technology. They were intended to highlight program gaps, overlaps, and need for improved coordination among the Services. Each showed the objectives and general lines of effort for each Service in the area it addressed. Inputs from the Services included:

- Objectives, problems whose solution would aid attainment of the objectives, and technological strategy for developing the Technology Base
- Present state-of-the-art capability pertinent to each objective

- Relative importance of each objective (when attained) to overall combat capability

- Technical work planned for attainment of each objective.[17]

Collectively, the objectives set forth in these papers were expected to comprise a comprehensive set of the important, unsolved (operating) problems whose solution provided an opportunity to utilize available technology or new technology when available.

In an overview analogous to Technology Coordinating Papers, Area Coordinating Papers were supposed to identify operating problems for the current period and mid-range future, identify and describe programs for dealing with those problems, and predict the capabilities that would result from such programs fulfilling their advertised potential.

The procedures followed in preparing these papers varied among the members of the DDR&E's staff. In some cases, the individual prepared the first draft and sought comments from the Services. In others, a sizable team of Service representatives was formed to prepare the document.

The process was viewed with concern by many in the Navy. It appeared to portend increased centralization of technology program planning despite the emphasis on delegation articulated in the early 1970's by Deputy Secretary of Defense Packard. A list of the documents prepared during the era is presented in Exhibit III-11.

EXHIBIT III-11
DDR&E Coordination Papers 1970-1973

Technology Coordination Papers (TCPs)	Area Coordination Papers (ACPs)
Propulsion Technology Missiles and Space Vehicles	Air-to-Ground Munitions
Materials	Defense Suppression
Structures	Ocean Surveillance (Part I, Undersea)
Aircraft Propulsion Technology	Combat Search and Rescue
Medical and Biological Sciences	Interoperability of Tactical Data System
Human Resources	Navigation
	Space Communications
	Tactical Nuclear Weapons
	Environmental Quality

PLANNING AND JUSTIFYING ADVANCED DEVELOPMENT

When the six program categories were established, those technology projects which were of sufficient size or importance to merit special management attention were classified as Advanced Development. In 1962, the Navy's RDT&E Program consisted of 15 such projects totaling $52,484,000. The nature of projects varied considerably. Some were little more than aggregates of experimental effort that might have been supported under Exploratory Development except for the funding limitations of that category and the priority OPNAV attached to the work involved. Other projects supported development and testing of experimental vehicles such as hydrofoil craft, air-cushion vehicles, and VTOL aircraft or advanced subsystems such as fuel cells or shipboard gas turbines. A few were directed at fulfilling the prerequisites for full-scale development of weapons systems prior to approval for Engineering Development.

This heterogeneity was permissible under the definitions of the Exploratory and Advanced Development categories. Both definitions permitted hardware development and experimentation short of engineering for Service use. Both categories were directed toward establishing the feasibility of new concepts. Aside from the basis upon which program control was to be exercised, the main distinction between the two categories rested on the interpretation of what was a minor development effort and what was a major development project.

In practice the basis upon which program control was exercised became the principal and overriding distinction between the two categories. The bureaus controlled new starts in Exploratory Development; OPNAV approval was required for new Advanced Development projects. Under the Navy's planning system of 1962, each Advanced Development project required an Advanced Development Objective issued by OPNAV and, unless specifically exempted by DDR&E, each required a Technical Development Plan. Thus, Advanced Development projects were subjected to a level of OPNAV scrutiny that contrasted sharply with practices governing comparable technology programs earlier in the era.

Although the official procedures for planning and justifying Advanced Development projects changed little during the remainder of the era, the process consumed a substantial portion of the time and energy of those involved. Two developments, discussed in the paragraphs below, were particularly significant in this context.

Project SMEADO

In the 1960's the transition between Exploratory and Advanced Development became an important hurdle in the life of a new system concept or equipment development project. The bureaus met this challenge by mounting substantial efforts to market

their ideas in OPNAV and DDR&E. Project SMEADO (Selected Major Exploratory and Advanced Development Objectives) was probably the most ambitious effort of this type.

Initiated in 1963 by Dr. Frank Tanczos in BuWeps, Project SMEADO was intended to help focus Exploratory Development on the "building blocks" for new systems and to provide a means of communicating with potential OPNAV sponsors for purposes of "selling" new starts in Advanced or Engineering Development. Initially, SMEADOs were submitted as unsolicited Proposed Technical Approaches in accordance with the Navy's planning system of 1962. Later, these were summarized annually in the form of a SMEADO Catalogue that was given wide distribution in the Navy R&D community. NAVAIR continued the practice after the Navy's reorganization of 1966 until the SMEADO Catalogue was replaced by an annual NAVAIR Advanced Development Plan.

Approaches varied among the systems commands. By the end of the era, NAVELEX was publishing an annual program plan of its own, while NAVORD relied primarily on Advanced Systems Concepts which had evolved in the Navy Technological Forecast program.

While opinions vary as to the efficiency of these initiatives, they are symptomatic of the emphasis on documentation which was a prominent feature of RDT&E program compartmentalization and centralized control of major projects. They are also indicative of the extraordinary efforts that were necessary to gain approval of new and potentially risky projects. As one senior OPNAV official said when interviewed during the course of this review: "The easiest way to put people to sleep around here is to label a project a high-risk endeavor."

Despite the difficulties involved, the Navy's Advanced Development Program grew tenfold in total projects and dollars during this period (see Exhibit III-12). While cause and effect have not been assessed, it is reasonable to assume that the bureau/systems command initiatives, described above, were partially responsible for this growth.

Concept Formulation

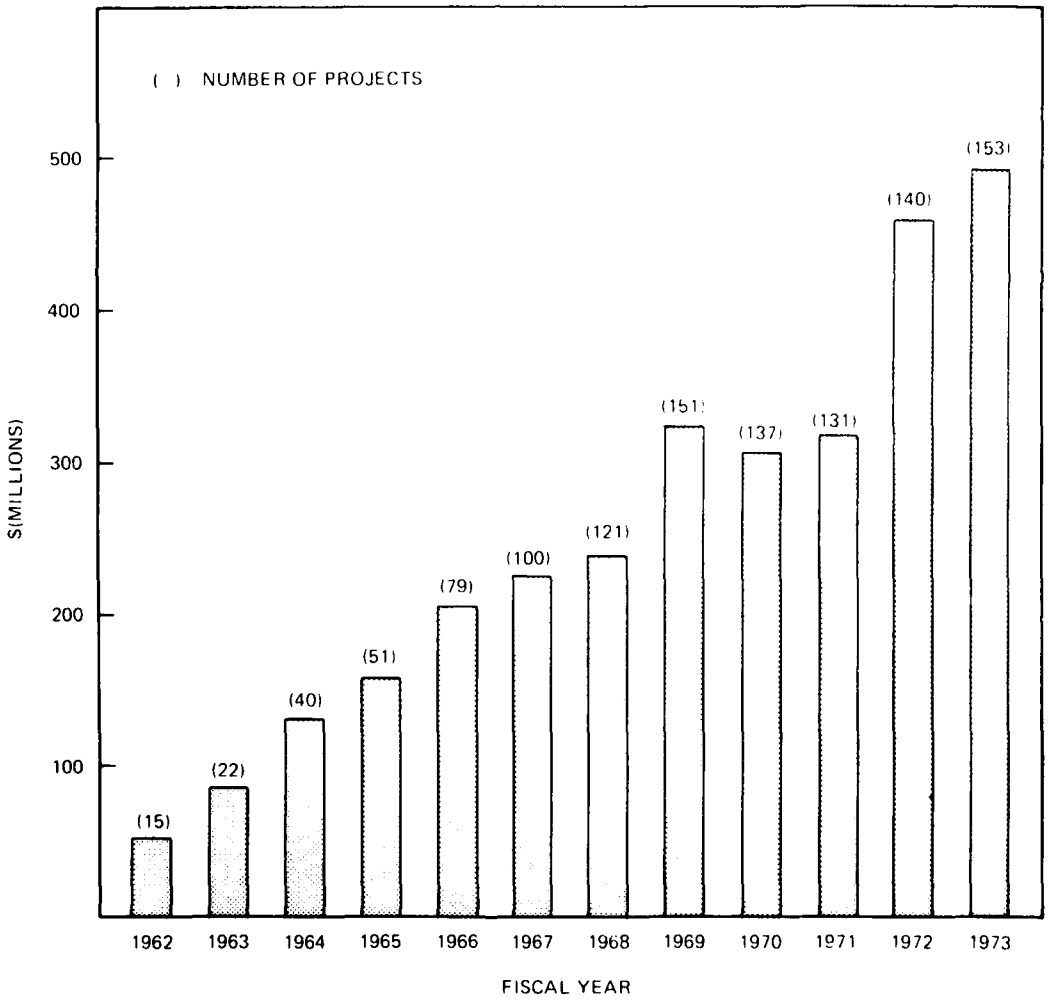
In 1965, OSD introduced the term "Concept Formulation" into the R&D management jargon and defined it as follows:

> Concept Formulation describes the activities preceding a decision to carry out Engineering Development. These activities include accomplishment of comprehensive system studies and experimental hardware efforts under Exploratory and Advanced Development and are prerequisite to a decision to carry out Engineering Development.[18]

The idea of Concept Formulation was transformed by the bureaucracy into a highly structured process which substantially increased the degree of detailed planning incident to justifying individual projects. Moreover, in 1965, the Secretary of Defense directed that all new FY69 and subsequent shipbuilding programs utilize Concept Formulation techniques, provided the uses of such techniques did not disrupt existing schedules and established organizational structures.[19] Thus, the preliminary design and tradeoff studies for new ships came to be supported under the RDT&E program for the first time.

While the process had very little impact on the way Exploratory Development effort was planned and executed, the Advanced Development category soon assumed a dual character. Part of the category consisted of broadly conceived projects to advance the

EXHIBIT III-12
Advanced Development Projects
1962-1973



SOURCE: DATA PROVIDED BY OFFICE OF NAVAL RESEARCH.

state of the art in some field of technology. The distinction between this work and Exploratory Development became increasingly obscure except that it was subjected to a degree of planning and review characteristics of Category 6.3. It was this type of effort that Dr. Foster included in his reference to the Technology Base, discussed earlier.

The other part of Advanced Development comprised projects that were focused on fulfilling the prerequisites for full-scale development. It was not unusual for these projects to be continued beyond their expected date of completion due to failure to achieve expected approvals for full-scale development. One of the effects of this "logjam" in decisionmaking was the deferral of timely work on other projects that otherwise had a claim on Advanced Development resources.

In the early 1970's, David Packard, then Deputy Secretary of Defense, acted to remove much of the DOD-level procedural detail including the DOD directive governing Concept Formulation. This was, however, but one aspect of a comprehensive change in the DOD process for acquisition of major systems discussed in the next section.

PLANNING AND JUSTIFYING ENGINEERING DEVELOPMENT

The 1960's saw an unprecedented involvement by OSD in deciding what projects would be undertaken. The initial thrust of this involvement was through the insistence on more comprehensive planning documentation and increased emphasis on systems analysis and cost-effectiveness studies to aid OSD in decisionmaking. Since the Navy could no longer initiate work on full-scale development projects without prior OSD approval through the program change procedure, such authority could not be delegated to the chiefs of bureaus and offices as had been the practice in earlier years.

The planning system introduced by DCNO(Dev) in 1962 reflected these "facts-of-life" by formalizing the user-producer dialogue in terms of documents calculated to discipline the decisionmaking process. Nevertheless, the OSD staff was rarely completely satisfied with the evidence produced as a result of this process. Time and time again, they concluded that viable options had been prematurely foreclosed and directed further study. Results of one study would suggest another, either at Navy initiative or OSD insistence. For example, prior to conducting a formal program definition phase for the CONDOR guided missile, over 150 Navy studies were made on various technical aspects of the program.

For many involved in this process during the early 1960's, planning and justification of projects seemed to have become an end unto itself rather than the means to an end. Proposed Technical Approaches underwent protracted reviews before Specific Operational Requirements were issued. Technical Development Plans followed a similar pattern. While formal DDR&E approval of TDPs, in themselves, was not required by official

directives, the DDR&E staff, in practice, assumed the right to disapprove. Such disapproval was, of course, enforceable through DDR&E control over the purse strings. Thus, DDR&E review compounded delays inherent in the OPNAV review. It was not unusual for Technical Development Plans to be overtaken by events and substantially out of date before approval was issued by OPNAV.

The OSD directive that defined Concept Formulation also established a requirement for a formal Contract Definition process and stated that conditional approval to proceed with Engineering Development would depend on evidence that Concept Formulation had accomplished the following prerequisites:

- Primarily engineering rather than experimental effort was required, and the technology needed was sufficiently in hand
- The mission and performance envelopes were defined
- The best technical approaches had been selected
- A thorough tradeoff analysis had been made
- The cost effectiveness of the proposed item had been determined to be favorable in relationship to the cost effectiveness of competing items on a DOD-wide basis
- Cost and schedule estimates were credible and acceptable.

These guidelines, coupled with the Contract Definition procedures (addressed in Chapter 17), had a pronounced impact on planning and justifying Engineering Development projects. Not only had OSD officials placed stringent limitations on acceptable risk in Category 6.4, they had also put the military departments on notice that OSD was to be deeply involved in appraising plans for project execution.

If there had been any constraints on the quantity of paperwork involved in planning and justifying Engineering Development, they quickly disappeared. Proposed Technical Approaches and Technical Development Plans blossomed into documents which approached and sometimes exceeded 2 inches in thickness as demands for detailed information grew. Faced with limitations on personnel ceilings, bureaus and offices turned to contractors who specialized in preparing the required documentation.

The proliferation of procedures and planning documents peaked in the late 1960's as some approaches proved to be viable while others began to fall by the wayside. In 1967, the Development Concept Paper (DCP) came into use as a mechanism for coordinating

program decisionmaking in the OSD. DCPs were originally prepared by DDR&E in close coordination with the appropriate military service(s) for all new programs, or major engineering modifications to existing programs, classified as "important." They were used to gain Secretary of Defense approval to initiate or continue programs at critical decision points.[20]

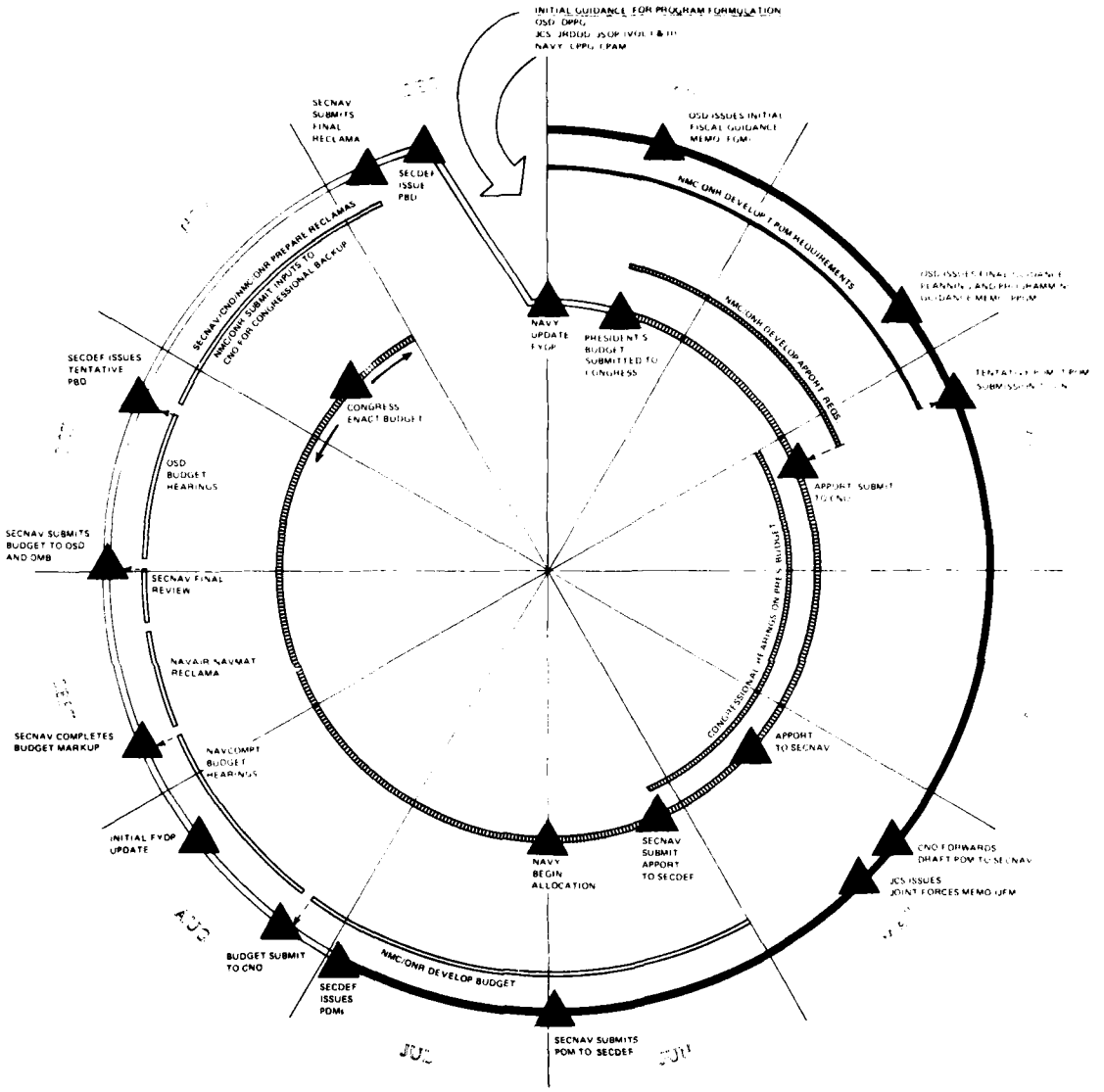
In 1969 Deputy Secretary of Defense Packard established the Defense System Acquisition Review Council to evaluate status of major defense systems at three major decision milestones in the life of a major program.[21] The Defense Systems Acquisition Review Council (DSARC) reviewed DCPs prepared for the milestone in question–project initiation, full-scale development, or transition from development to production–and made recommendations to the Secretary of Defense for his decision. This procedure was reflected in a DOD Directive issued by Packard in 1971.[22] The directive was clearly an attempt to reverse trends which had developed in the 1960's. It stated that responsibility and authority for the acquisition of defense systems would be decentralized to the maximum practicable extent consistent with the urgency and importance of each program, and it summarized the basic policies that would govern the process.

Packard succeeded in removing much of the OSD level procedural detail including the DDR&E requirements for a TDP, but evidence was mounting by the end of the era that history was repeating itself. A variety of steps preparatory to DSARC review had been instituted by the Navy Department as well as the DDR&E staff and the volume of paperwork to support system acquisition decisionmaking appeared once again to be growing.[23]

ADDITIONAL REFINEMENTS IN PLANNING AND PROGRAMMING

In 1973 the Navy program planning process depicted in Exhibit III-7 remained virtually unaltered except as noted in the sections above. However, OPNAV was considering substantial changes to bring its R&D planning system in line with principles reflected in DOD Directive 5000.1 as well as the refinements in the programming process which had evolved during the period. The most noteworthy changes in the programming process involved the generation of an annual Program Objective Memorandum (POM) as a prelude to the budgeting process. The POM that was submitted to the Secretary of Defense by the Secretary of the Navy recommended the total resource requirements within the parameters established in SECDEF guidelines. A highly simplified illustration of the POM cycle as it relates to the budgeting and appropriation process discussed in Part IV is presented in Exhibit III-13.

EXHIBIT III-13
Salient Features of the Programming/Budgeting Cycle 1973



NOTE: SEE GLOSSARY FOR DEFINITION OF ACRONYMS.

SOURCE: PREPARED BY BOOZ, ALLEN & HAMILTON INC. BASED ON DATA PROVIDED BY ASW PROJECT OFFICE (PM4).

Notes to Chapter 11

1. Memorandum, Harold Brown, DDR&E, Subject: RDT&E - Research Category, January 8, 1964.

2. Public Law 91-121, Section 203, November 19, 1969.

3. Personal Interview.

4. OPNAV Instruction 3910.3, Subject: Procedures for Planning, Coordination, Administration, and Reporting of the Navy RDT&E Program, March 30, 1959.

5. Department of the Navy, *Review of Management of the Department of the Navy, Research and Development Management Study*, Vol. II, Study III (Washington, D.C., October 19, 1962), NAVEXOS 2426B-3, pp. 152, 164.

6. Department of the Navy, *Review of Management of the Department of the Navy*, Vol. I, (Washington, D.C., December 15, 1962), NAVEXOS P2426A, p. 95.

7. Personal Interview.

8. Personal Interview.

9. NAVMAT Instruction 3910.10, Subject: Implementation Procedures for Navy Technological Forecast Program, August 29, 1967.

10. NAVMAT Instruction 3900.10B, Subject: Implementation Procedures for Navy Technological Forecast Program, December 18, 1970.

11. Personal Interview.

12. NAVMAT Instruction 3910.7, Subject: Planning Procedures for Exploratory Development Programs, February 10, 1967.

13. Personal Interview.

14. NAVMAT Instruction 3910.12, Subject: Exploratory Development Program Planning Structure, January 5, 1968.

15. Personal Interview.

16. Personal Interview.

17. Department of the Navy, *RDT&E Management Guide, Part I: System Description* (Washington, D.C., July 1972), NAVSOP-2457, p. 18.

18. DOD Directive 3200.9, Subject: Initiation of Engineering and Operational Systems Development, July 1, 1965.

19. Memorandum, Robert McNamara, Secretary of Defense, February 19, 1965 (Secret).

20. Department of the Navy, *RDT&E Management Guide*, (Washington, D.C., July 1969), NAVSOP-2457 pp. 2-17.

21. Memorandum, David Packard, Deputy Secretary of Defense to Secretaries of Military Departments, Subject: Establishment of a Defense Systems Acquisition Review Council, March 3, 1969.

22. DOD Directive 5000.1, Subject: Acquisition of Major Weapons Defense Systems, July 13, 1971.

23. Personal Interview.

SUMMARY

PRINCIPAL TRENDS IN NAVY R&D PROGRAM PLANNING 1946-1973

Exhibit III-14 depicts the principal milestones in R&D program planning during the era. Planning milestones are connected by trend lines to highlight sequential relationships. Organizational milestones are included where they seem particularly pertinent to changes in the planning process.

An examination of sequential relationships reveals that changes in the program planning process correlates closely with the increased number of organizational layers and the concomitant proliferation of staffs and reviewing authorities. This relationship is also discernible in the paragraphs below.

EVOLUTION OF NAVY PLANNING SYSTEMS

As indicated on the chart, the assignment of R&D responsibilities in OPNAV and the creation of the New Development Board–later expanded and renamed the Navy Research and Development Review Board–were followed closely by the development of the Navy R&D planning system of 1948. The system was both simple and functional, involving only three types of requirements documents: Planning Objectives and Operational Requirements, which were issued by OPNAV; and Research Requirements which were the responsibility of CNR.

Under this system OPNAV stated requirements in broad, general terms while the chiefs of material bureaus had full authority to plan and initiate R&D programs to fulfill their responsibility for meeting the material needs of the fleet. Overall coordination of priorities was effected in OPNAV through annual program budget reviews conducted by the Navy Research and Development Review Board. Once this process was completed, however, bureau chiefs had primary responsibility under SECNAV for justifying their budgets outside of the Navy Department to the Bureau of the Budget and the Congress.

The influence of OSD's Research and Development Board (RDB) on the Navy's planning system was apparent in the parallelism between Navy Planning Objectives and the RDB program categories. Perhaps of greater significance in terms of long-term trends was the RDB's insistence on formal reporting at the project level to which OPNAV objected. With this exception, the Navy R&D program planning process was relatively free of procedures imposed by OSD throughout the 1950's.

Within the Navy Department, however, procedural change followed organizational change as the R&D function at the OPNAV level and above grew in stature and authority. The New Development and Operational Division in OPNAV introduced Development Characteristics. The ACNO(R&D) established the Technical Development Plan, a requirement for CNO Weapon (Support) System Concepts, and annual program guidelines. The DCNO(Dev) restructured the RDT&E program, issued Exploratory Development Requirements, and accomplished a comprehensive overhaul of the Navy R&D planning system in 1962. This latter step was heavily influenced by the Planning, Programming, and Budgeting System (PPBS) and the six-part program structure instituted by OSD during Secretary of Defense McNamara's administration. By 1963 R&D planning and justification had grown considerably more complex. The trend toward complexity is graphically illustrated in Exhibit III-15.

THE DDR&E INFLUENCE

Internal Navy R&D planning procedures for system development projects remained relatively stable during the last decade of the era. The Navy was, however, kept quite busy responding to procedures imposed from above. The 1960's saw an unprecedented involvement by the DDR&E staff not only in deciding what projects would be undertaken but also in determining how they would be executed. The initial thrust of this involvement was through the insistence on more comprehensive planning documentation and increased emphasis on system analyses and cost-effectiveness studies as an aid to decisionmaking. In 1962 DDR&E adopted the Technical Development Plan (TDP) as the principal planning document for system development projects. The TDP, which the Navy bureaus had used to present plans for proposed projects in response to an Operational Requirement prior to issuance of a Development Characteristic, began to be viewed as a "contract" between the Navy and OSD.

The 1960's also saw the imposition by OSD of a number of weapons system acquisition procedures among which Concept Formulation and Contract Definition had a profound effect on program planning, justification, and decisionmaking. OSD directives governing these procedures emphasized an integrated acquisition process, thus reversing a trend toward R&D separatism evidenced earlier in the era. What was originally intended to be policy direction was, however, often transformed by bureaucracy into a morass of procedural constraints. Successive staff reviews led to further complexity and growth of the planning documents until they lost much of their value as tools for decisionmaking and management control. Moreover, alleged defects in TDPs were often used by those who were so disposed as a basis for delaying program commitments.

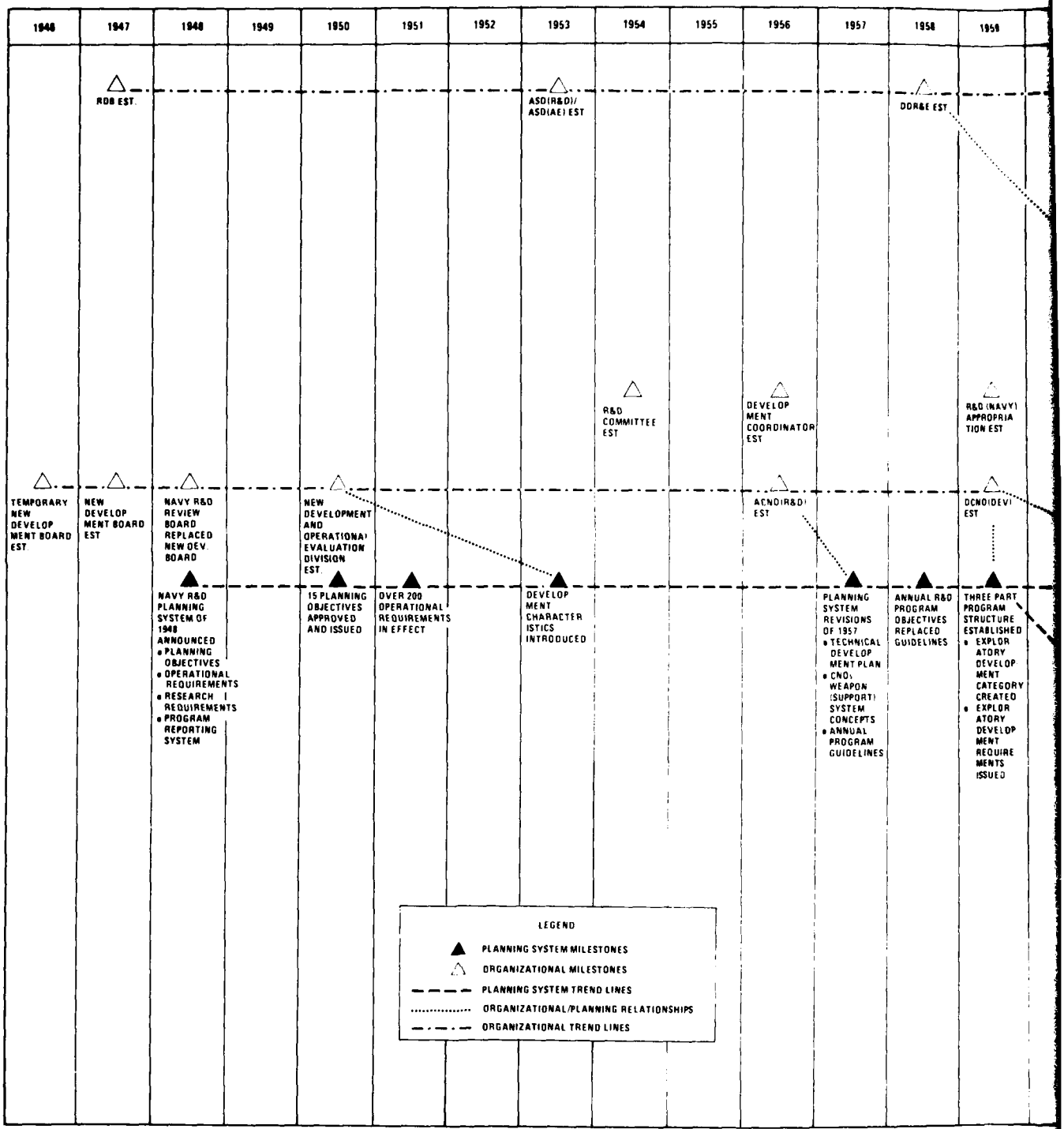
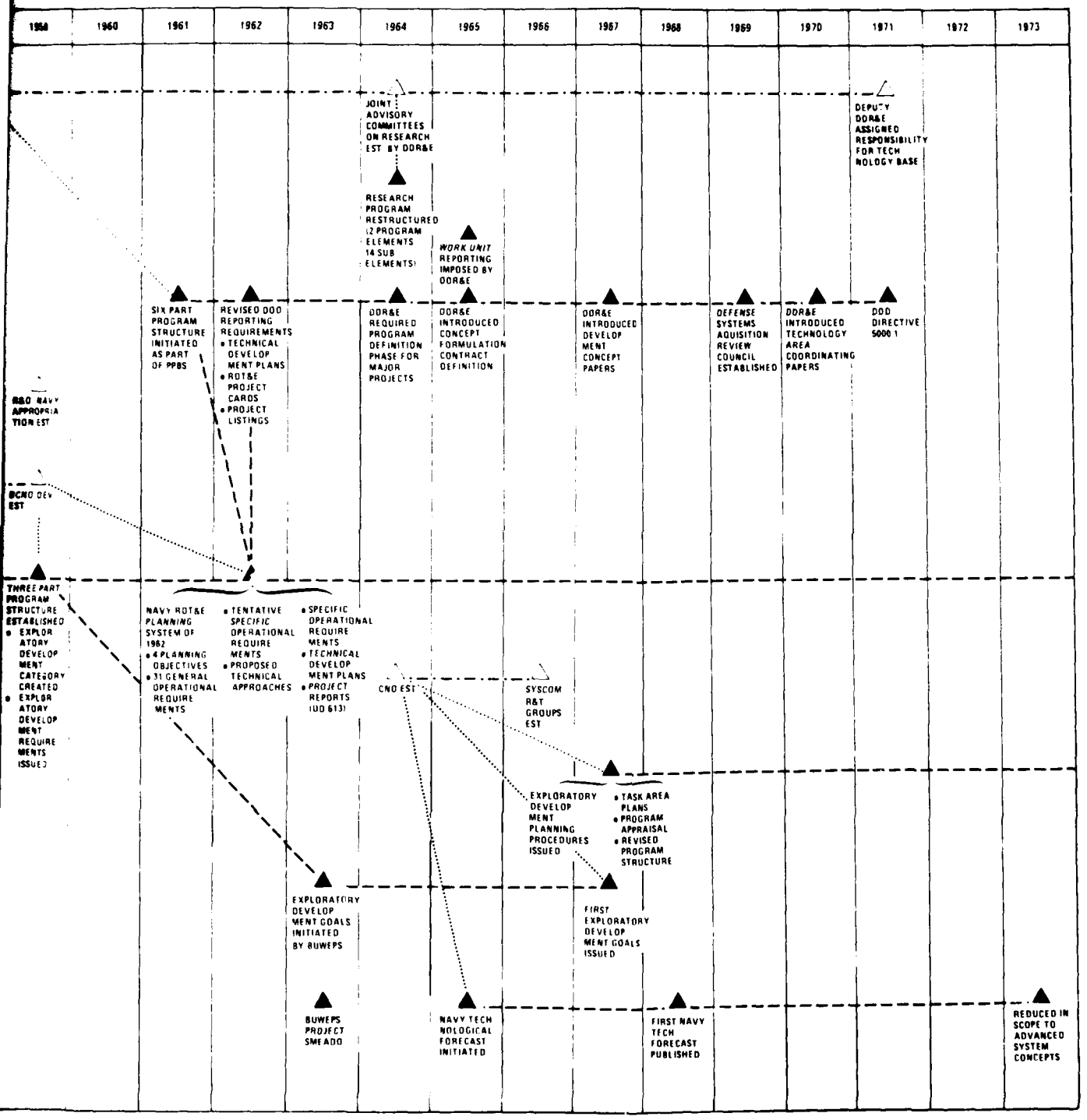
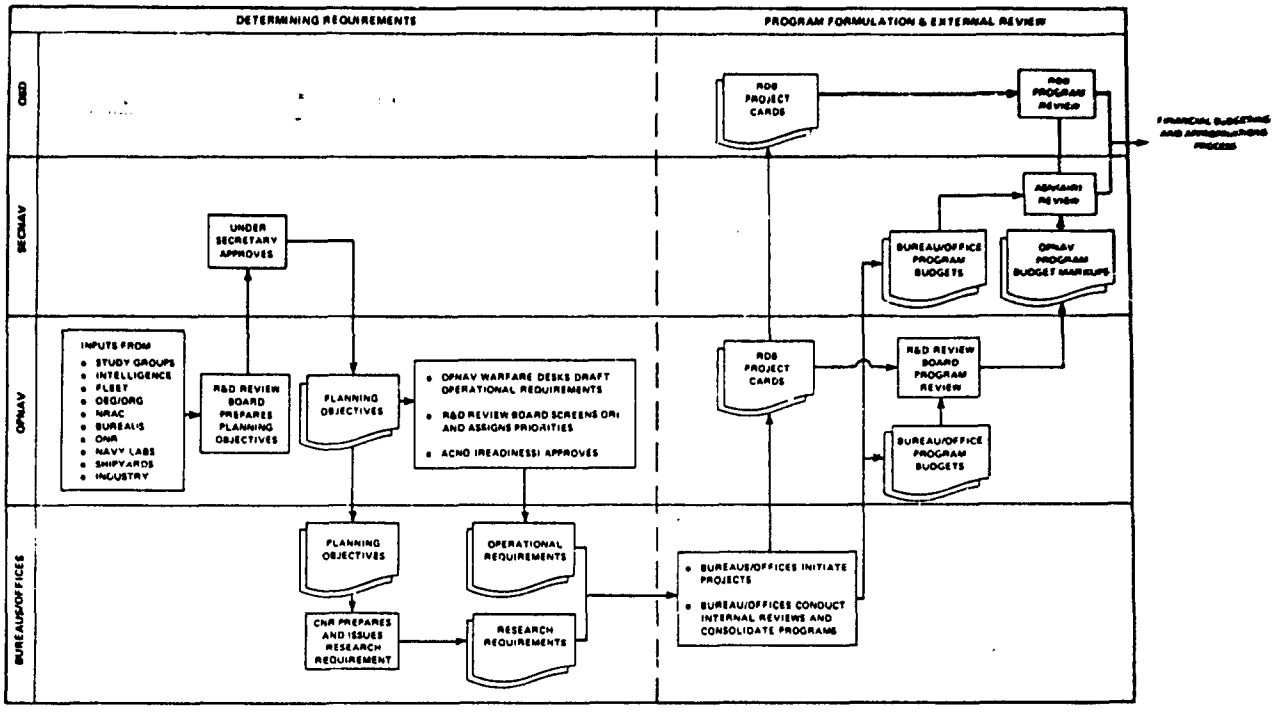

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ASD(R&D)/ ASD(AE) EST
DDR&E EST
R&D COMMITTEE EST
DEVELOP MENT COORDINATOR EST
R&D (NAVY) APPROPRIA TION EST
TEMPORARY NEW DEVELOP MENT BOARD EST.
NEW DEVELOP MENT BOARD EST
NAVY R&D REVIEW BOARD REPLACED NEW DEV. BOARD
NEW DEVELOPMENT AND OPERATIONAL EVALUATION DIVISION EST.
ACNO(R&D) EST
DCNO(DEVI EST
NAVY R&D PLANNING SYSTEM OF 1948 ANNOUNCED
• PLANNING OBJECTIVES
• OPERATIONAL REQUIREMENTS
• RESEARCH REQUIREMENTS
• PROGRAM REPORTING SYSTEM
15 PLANNING OBJECTIVES APPROVED AND ISSUED
OVER 200 OPERATIONAL REQUIREMENTS IN EFFECT
DEVELOP MENT CHARACTER ISTICS INTRODUCED
PLANNING SYSTEM REVISIONS OF 1957
• TECHNICAL DEVELOP MENT PLAN
• CNO's WEAPON (SUPPORT) SYSTEM CONCEPTS
• ANNUAL PROGRAM GUIDELINES
ANNUAL R&D PROGRAM OBJECTIVES REPLACED GUIDELINES
THREE PART PROGRAM STRUCTURE ESTABLISHED
• EXPLOR ATORY DEVELOP MENT CATEGORY CREATED
• EXPLOR ATORY DEVELOP MENT REQUIRE MENTS ISSUED
LEGEND
PLANNING SYSTEM MILESTONES
ORGANIZATIONAL MILESTONES
PLANNING SYSTEM TREND LINES
ORGANIZATIONAL/PLANNING RELATIONSHIPS
ORGANIZATIONAL TREND LINES

EXHIBIT III-14
Significant Milestones for R&D Program Planning 1946-1973

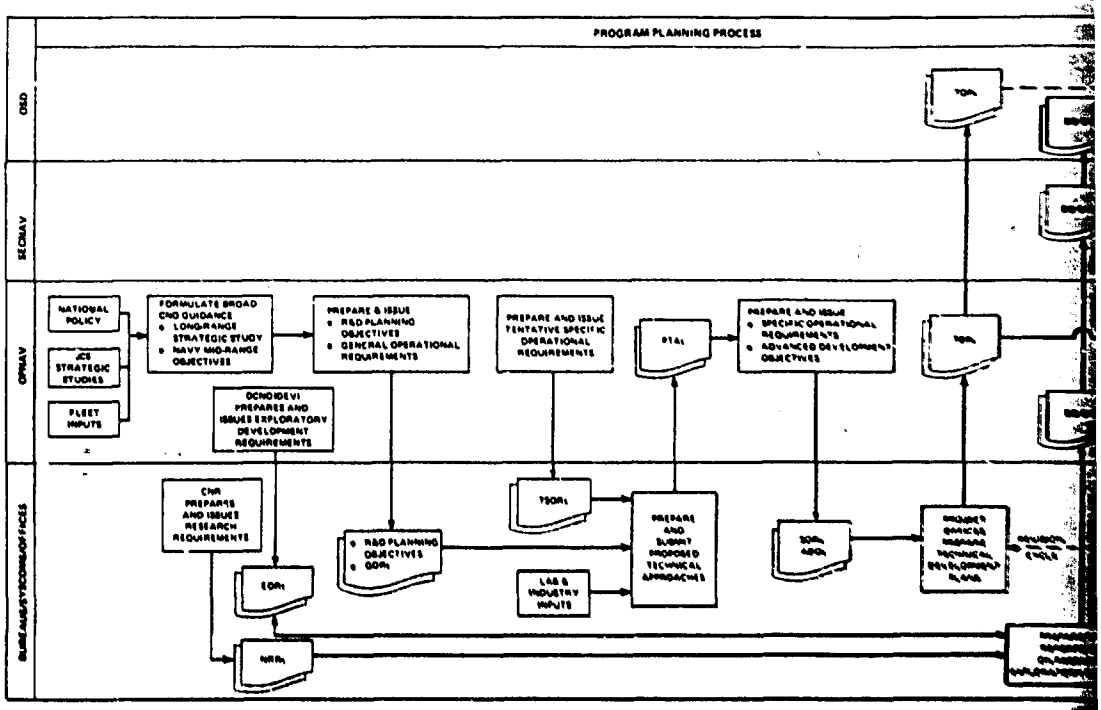


1951



SOURCE: PREPARED BY BOOZ, ALLEN & HAMILTON INC.

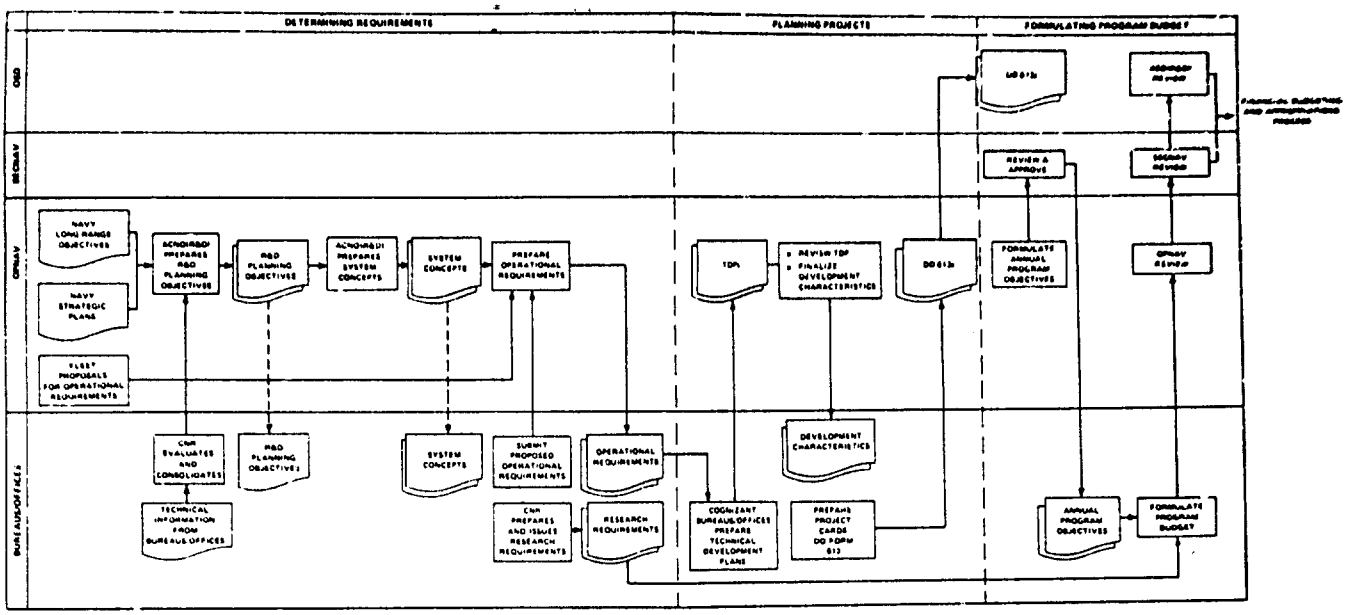
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SOURCE: PREPARED BY BOOZ ALLEN & HAMILTON INC

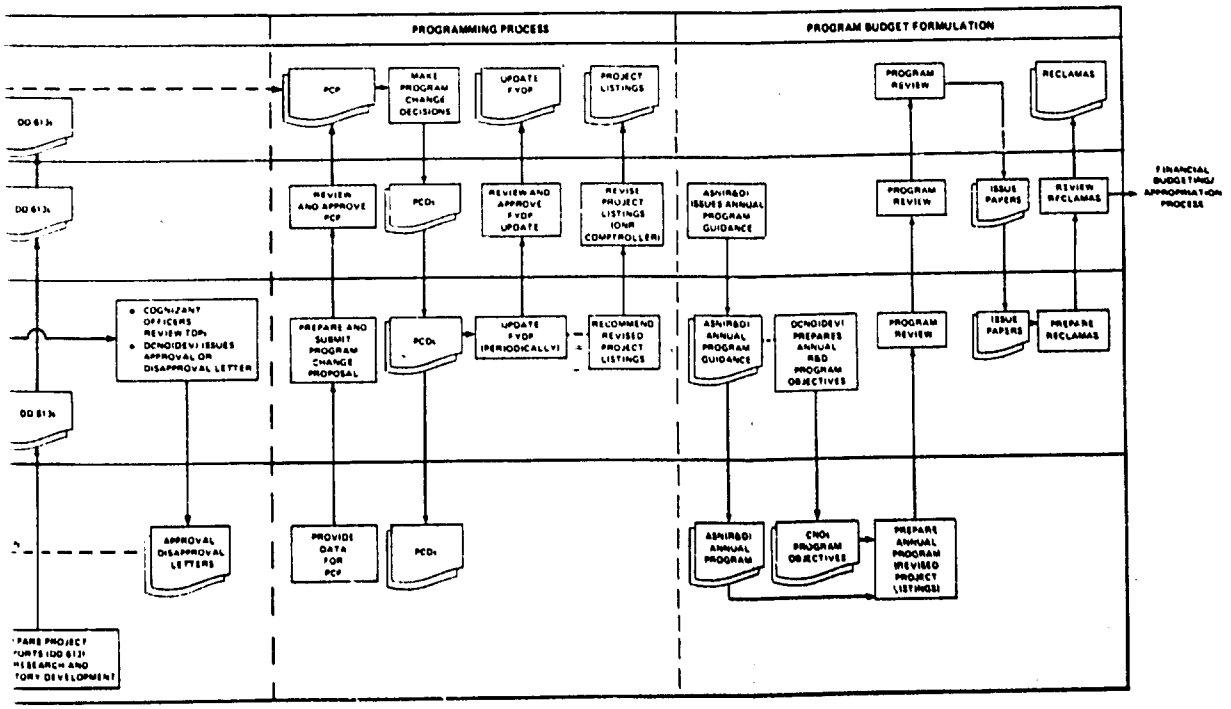
EXHIBIT III-15
Growth in the R&D Program Planning and Justification Process Through the Mid-1960's

1958



SOURCE: PREPARED BY BOOZ, ALLEN & HAMILTON INC.

ARLY 1960's



While the procedures described above applied primarily to system-development projects, the planning of technology programs also underwent substantial change during the 1960's. In this context, the compartmentalization of the RDT&E program stemming from the introduction of the six-part program structure in 1962 had a profound impact. One effect, exemplified by BuWeps' project SMEADO, was the substantial efforts mounted by bureaus and systems commands to market their ideas to OPNAV and DDR&E to promote transition between categories. Another effect, exemplified by the creation of the Office of CND and the SYSCOM research and technology groups, was increased organizational specialization along program category lines. This was followed sequentially by a number of special planning procedures for Exploratory Development shown on the milestone chart.

Reporting of technology programs also became more detailed. The reporting system initiated by the RDB evolved through a series of refinements into the R&D Planning Summaries and Research and Technology Work Unit Summaries. These reports were adapted to a computerized data storage and retrieval system in the Defense Documentation Center.

In the late 1960's, the DOD procedures established early in the decade began to change perceptibly. In 1967, the Development Concept Paper (DCP) came into use as a mechanism for coordinating program decisionmaking in the OSD. DCPs were originally prepared by DDR&E in close coordination with the appropriate military department for all new programs or major modifications to existing programs, classified as "important." DCPs were used to gain SECDEF approval to continue programs at critical decision points such as a decision to deploy a system or to authorize a new expenditure threshold. The system was refined in 1969 with the introduction of the Defense Systems Acquisition Review Council (DSARC), also reflected in DOD Directive 5000.1. The DSARC reviewed DCPs for each of the three major decision milestones in the life of a major program and made recommendations to the SECDEF for his decision. Finally, as the era drew to a close, Technology Coordinating Papers and Area Coordinating Papers were introduced as additional mechanisms for coordinating technology base program planning.

RELATIONSHIP OF CHANGES TO PERCEIVED NEEDS

In view of the correlation between organizational changes and those in the planning process, a convincing argument can be made that procedural formality and complexity were inevitable by-products of organizational growth. Nevertheless, it must be presumed that changes were introduced to satisfy needs which responsible people perceived as legitimate at the time. The paragraphs below examine trends in R&D program planning in terms of those needs.

Throughout the era there was a perceived need to provide the R&D community with adequate guidance concerning projected requirements of the fleet toward which technology programs should be directed. A vast system of documentation, ranging from top-level Joint Chiefs of Staff strategic planning documents to OPNAV's General Operational Requirements (GORs), emerged during the era and were dedicated, at least in part, to providing long-term guidance to the bureaus, offices, and laboratories engaged in research and development. Later, the Chief of Naval Development undertook the translation of GORs into Exploratory Development Goals (EDGs) in an effort to provide more meaningful inputs to the technical community. However, neither the GORs nor the EDGs found general acceptance as useful guidance documents. Dealing as it did with long-range technology programs, the guidance tended to be either too general, providing little guidance at all, or so specific that it allegedly inhibited exploration of relevant alternatives. Some believed that "technology push" was a more realistic basis for formulation of technical strategy than "requirements pull." At the end of the era, the problem of providing effective long-range guidance to the R&D community without appearing to inhibit innovation remained a persistent unresolved issue for Navy Department officials.

At the systems development end of the R&D spectrum, planners perceived a need for more precise definition of requirements in terms of hardware characteristics as a prerequisite to project approval. First, Development Characteristics were introduced. Later, more formal procedures were developed to promote an orderly user-producer dialogue leading to a decision on Specific Operational Requirements (SORs). These requirements reflected the selection by OPNAV of a Proposed Technical Approach submitted by the "producer" organization. But Specific Operational Requirements carried little weight with some members of the DDR&E staff, who frequently questioned their legitimacy as requirements or considered them as evidence of premature foreclosure of options which they felt duty-bound to explore. Accordingly, issuance of a SOR by no means guaranteed project approval. By the same token, projects were sometimes initiated without prior issuance of a SOR.

As decisionmaking gravitated upward in the organization and lines of communication lengthened, planners became increasingly concerned with obtaining adequate inputs from the technical community. Bureau long-range plans of the mid-1950's were an attempt to catalyze this process. Unsolicited Proposed Technical Approaches, Project SMEADO, and the Navy Technological Forecast in the 1960's were also directed toward this perceived need. Experience with these communications mechanisms indicated that response of members of the technical community was most enthusiastic when they believed that their inputs had a reasonable chance of influencing the program. For example, there was no dearth of Proposed Technical Approaches or ideas for Project SMEADO. They frequently led to new starts in the programs of their originator. In contrast, the broad-based parts of the Navy Technology Forecast (Part I - Scientific Opportunities and Part II - Technological Capabilities) failed to stand the test of time.

The survival of Part III, on the other hand, attests to the preference of both the technical community and headquarters planners for presentation of technological opportunities in terms of Advanced System Concepts.

Despite this apparent preference, Advanced System Concepts were only marginally effective as a means of focusing technological effort. Staff planners were generally unable to provide official sanction of concepts entailing substantial technical risk without appearing to underwrite a specific system requirement. Nevertheless, as the era drew to a close some of the systems commands were attempting to relate their Exploratory Development programs to generic system concepts as an aid to their internal planning.

The perceived need for more comprehensive analyses of tradeoffs between technical complexity, reliability, leadtime, cost, etc., received substantially increased attention from the 1950's on. In the early 1960's, this trend continued as key officials in OSD concluded that greater emphasis on quantitative analysis of alternatives was essential to prevent proponents of individual projects from prematurely foreclosing viable options. Most people interviewed during this Review expressed the belief that this emphasis was both timely and beneficial in that the military departments became more sensitive to the essential elements of R&D decisionmaking. Proponents of individual projects could no longer prevail simply by quoting an Operational Requirement. On the other hand, the proliferation of "paper studies" engendered by this trend frequently led to procrastination, increased leadtime, and diversion of management talent. In addition, major commitments were sometimes unduly influenced by analytical assumptions not validated by experimental evidence or operational experience. As the costs and uncertainties of complex systems increased, overruns also mounted and top officials became more insistent that project plans clearly show a successful end-of-the-road with no pitfalls along the way. Readiness to make decisions under conditions of uncertainty, so essential to effective R&D management, became increasingly rare.

Uniformity and minimum standards of excellence in project planning were additional perceived needs. Staff planners wanted to encourage subordinate levels to "think things through." A standard format such as the TDP was viewed by some as a way to promote this objective. Others used it as a mechanism through which they could superimpose their judgment on that of people responsible for program execution. Staff personnel with little or no accountability for the success or failure of an endeavor were able in this way to insert themselves into the decisionmaking process, sometimes imposing personal viewpoints that conflicted with policy of officials they represented. In some cases, accountability for decisions taken was thoroughly confused.

COMMENTARY

The changes in R&D program planning during the era were symptomatic of the pronounced shift in decisionmaking authority from those responsible for executing R&D

programs to higher levels in the Navy Department and the Office of the Secretary of Defense. This shift was accompanied by the evolution of a highly stylized framework of formal planning procedures to support centralized decisionmaking in an increasingly complex organizational environment.

While persons interviewed readily acknowledged the need for top-level control of major system acquisition decisions, opinions varied with respect to the intermediate steps in the planning process. Many expressed considerable concern with the impact such procedures had on development leadtime and the cost of conducting R&D business in the Navy Department. They felt that reliance on formal procedures and paperwork had long since passed the point of diminishing returns in terms of cost and time invested versus benefits achieved. Moreover, they considered these mechanisms to be poor substitutes for the informal give and take which had characterized the R&D program planning process early in the era. They pointed to instances where documentation had been ineffective or where overreliance on it had produced delays that could have been avoided through more direct communications. On the other hand, there is considerable evidence to suggest that many of the successful Navy R&D managers, intent on achieving near-term objectives, relied on whatever control over the purse strings they could achieve to get things done in spite of the system. They viewed the paperwork as something to be endured but not taken too seriously.

Deputy Secretary Packard's 1971 directive emphasized delegation of responsibility and authority for system acquisition to the military departments and removed much OSD-imposed procedural detail including requirements for Concept Formulation, Contract Definition, and TDPs. Nevertheless, as the era drew to a close, there was insufficient evidence to support the conclusion that the trend toward centralized direction and control of the R&D planning process had been decisively reversed.

PART IV

R&D FINANCIAL BUDGETING AND APPROPRIATIONS

To the degree that it can be separated from program planning, the process by which the Navy Department obtained and allocated financial resources to support its R&D program is reviewed in this part. Briefly defined, the process involved financial budget formulation and execution. It was carried out in successive stages in which funds were requested by the Executive, appropriated by Congress, apportioned to the Navy bureaus and offices, and allocated to R&D program managers for obligation and expenditure.

While each stage of the financial budget formulation and execution process played a vital role, congressional approval of the fiscal year appropriation was unequivocally the focal point of top-level R&D management. Based on financial budget estimates presented and justified to Congress, the final appropriation was not only the means by which the character, extent, and often the life of the program were determined, but also represented the legal framework within which the program was realized. Emphasis in this part will therefore be placed on those aspects of the financial management process that supported or affected annual appropriations for Navy R&D. Details of commitment, obligation, expenditure, and accounting are omitted in the interest of brevity.

Several trends in Navy R&D financial budgeting and appropriations are discernible in the period following World War II. In the first instance, there was an almost constant effort to define and aggregate into one discrete account the entire Navy R&D program, which had been widely dispersed among the various bureaus' appropriations until 1954. Simultaneously, there was a shift in focus from the organizational entities administering R&D funds to the various elements into which the program was broken down for higher review and approval. This was accompanied by a parallel increase in centralization of management control over R&D financial budgeting at ever-higher echelons with attendant loss of flexibility at the program management level. A further significant characteristic of the period was the OSD attempt, culminating in the early 1960's, to integrate the previously separate processes into a cohesive planning, programming, and budgeting system. Finally, the years 1946-1973 show a steady increase in R&D funding levels, per se, which were at least partly attributable to the cumulative effects of the expansion of the R&D account in 1959 to include related test and evaluation.

CHAPTER 12

NAVY RESEARCH AND DEVELOPMENT BUDGET FORMULATION AND APPROPRIATIONS 1946-1953

In the early post-World War II years, the entire process of financial budget formulation and execution for research and development clearly reflected the bureau chiefs' unquestioned responsibility, authority, and control of Navy research and development within the framework of responsiveness to established fleet requirements. This was evidenced in the procedures by which the budget was derived and justified, in the bureau chiefs' authority to reprogram funds, and even in the structure of the appropriations acts themselves.

To the degree that the bureau chiefs' responsibilities and authority were clear and complete, the Navy program for research and development, per se, was virtually invisible as an entity and defied accurate financial definition. The following sections describe these features and the incipient trend, begun a few years after the war, toward altering them.

OBTAINING R&D RESOURCES 1946

The process of obtaining resources for research and development (as for any military function) was always time consuming. For a year and a half preceding the start of the fiscal year, most aspects and participants in Navy research and development, from scientific research to the introduction of new weapons into the fleet, became involved in preparing and refining financial budget estimates to reflect program decisions as accurately as possible. The formulation of a fiscal budget, however, was far more than a translation of predetermined objectives into financial terms. With respect to research and development, in particular, program objectives were often subject to definition only in very imprecise and constantly changing terms. The budget approved by Congress in the form of appropriations was neither completely detailed nor consistent with rapidly changing policies and requirements. Some discretion and flexibility were therefore built into formulating the budget for research and development projects just as they were in planning the program.

Formulating the R&D Budget in the Navy Department

While obtaining and spending research and development funds varied slightly from bureau to bureau, the process and its participants were similar in most respects; a general

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representation is illustrated in Exhibit IV-1. There was constant interchange between those with program responsibility and those with fiscal responsibility. Budget reviews paced program revisions in an effort to ensure that budget estimates sent to Congress reflected the latest program decisions.

Research and development was carried out within the context of the overall program of each bureau. Accordingly, the bureau chief enjoyed latitude in the financial formulation and execution process commensurate with his authority over the entire program within his area of responsibility and according only to general program guidance and Operational Requirements established by OPNAV. The bureau chief also assumed almost total responsibility in preparing his budget estimates; he typically went over every item with his Assistant Chief for R&D and responded to the OPNAV "by exception" budget reviews.

At the start of the annual process, the Office of Budgets and Reports,* called for budget estimates. Project scientists and engineers in the bureaus' technical divisions submitted project recommendations; the respective division directors evaluated them regarding probable costs and available funds. Results were submitted to the Assistant Chief for R&D (or his equivalent), who assembled the research and development portion of the budget for the bureau chief. As a rule, justification of programs, other than certain major programs and projects, was usually made at this point on an informal basis, often orally, to the Assistant Chief.

After incorporating the research and development estimates into the overall bureau program budget, the bureau chief transmitted them to the budget officer in the Office of Budget and Reports, who organized and submitted them to the Secretary of the Navy for review, markup, and approval. Within the Navy Secretariat, ASN(Air) was technically responsible for R&D, but he exercised little, if any, influence in the financial budget process.

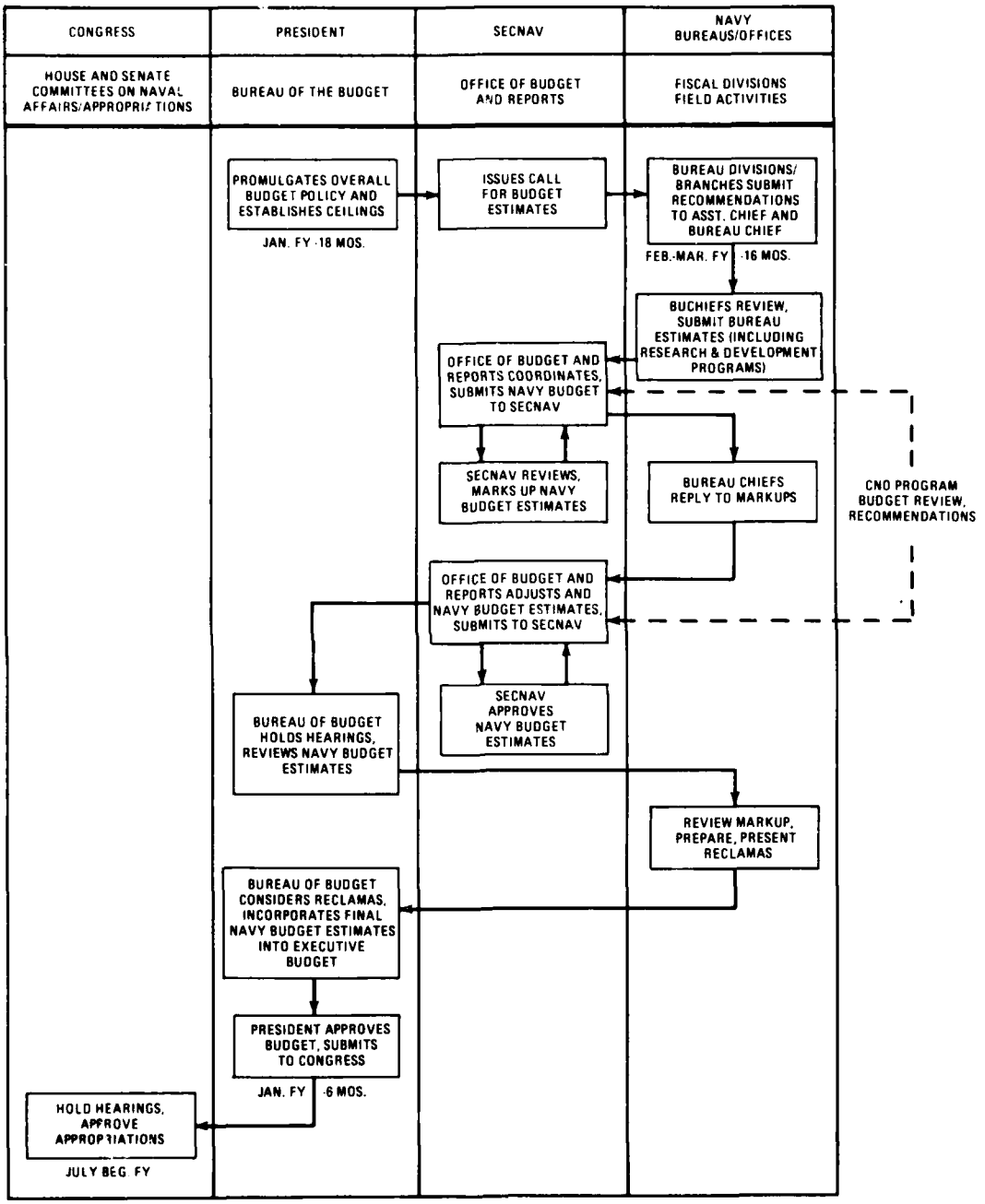
After the Secretary of the Navy had approved the various bureaus' estimates, the Navy Department's final budget, of which research and development was only a small and disaggregated part (ranging from 4 to 10 percent between 1946 and 1973) was submitted to the Bureau of the Budget for its initial review by external authorities.

Bureau of the Budget Review

The Bureau of the Budget (BuBud) assisted the President by assembling, correlating, revising, reducing, and/or increasing budget estimates received by the departments. The

* Established by Congress in the Office of the Secretary of the Navy in 1921 as a budget review office.

EXHIBIT IV-I
Financial Budgeting Process for Navy Research and Development Programs circa 1946



SOURCE: PREPARED BY BOOZ, ALLEN & HAMILTON INC.

Director was "the President's man." The potential power of the office was reflected in an order circulated shortly after its inception stating that:

> The Director of the Budget, in requesting information for the use of the President, acts for the President, and his calls upon the chiefs of bureaus and other administrative officers for purposes of consultation or information take precedence over the Cabinet head of a department.[1]

While the potential for exercising significant influence and power over the departments in the budget process was clearly written into its mandate, the bureau's power was nevertheless a function of the role each President assigned to it. In the immediate postwar years, the role with regard to budget levels was a strong one. President Truman called on the bureau not only to determine annual budget policy but also to establish national budget ceilings. Occasionally, budgetary limits were also set for specific executive programs or functions.

Typically, after the estimates for the Navy's budget were submitted to the Bureau for review and "markup," a separate examiner was assigned to each Navy bureau/office. Turnover within the BuBud sometimes caused unfamiliarity and/or lack of sympathy with the program, which was somewhat frustrating to those responsible for justifying the budget. An examiner's questioning of the technical feasibility of a project included in the estimates also suggested "improper technical judgments" to those affected. BuBud generally operated on a management-by-exception basis, however, and the Bureau official assigned to review the program usually knew it well and represented the Navy position effectively with other agencies or reviewers.

After consideration of reclamas made by the Navy in response to budget changes, the BuBud sent the estimates on to the President for incorporation into the overall Executive Budget. If a department failed to submit estimates in time for the President's Budget, BuBud inserted a one-line estimate for the department's program. While not binding, this one-line figure often proved a target (considerably lower than the department's detailed estimates finally represented) against which the department had to work in subsequent reviews and congressional hearings.[2]

BuBud was, therefore, instrumental both at the inception and conclusion of the budget process. Having set down policies and established ceilings, it acted subsequently as a final review board for the President (although SECNAV sometimes presented his views directly) and purveyor of the several components of the consolidated Presidential Budget to Congress.

Congressional Hearings and Appropriations

At the close of World War II, Congress acted through special committees to authorize programs and then appropriate funds to implement them. First, Committees on Naval Affairs (established in 1822) acted in both houses to authorize all Navy Establishment program activities, among them, Navy research and development projects. The Committees were extremely paternalistic, and hearings on the Navy's sundry legislation and budget estimates were thoroughgoing but sympathetic to naval power needs.

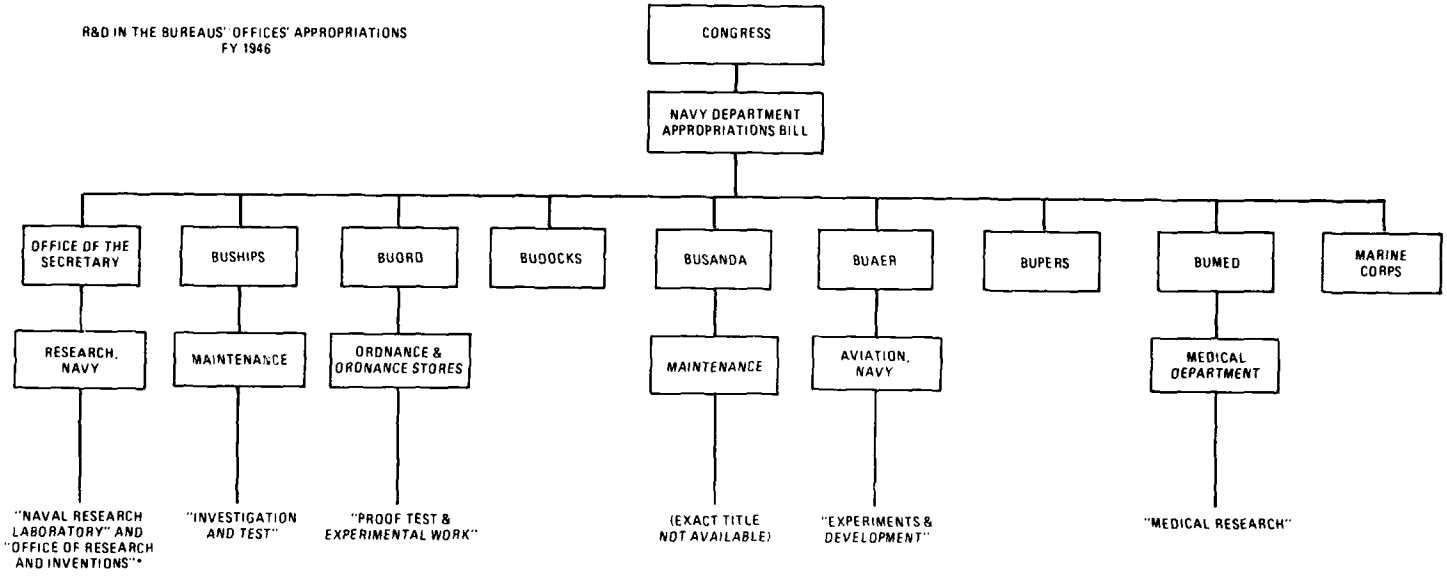
Following authorization of the Navy budget, for which more funds were consistently approved than were ultimately appropriated, hearings were held by the Committees on Appropriations in each house. Funds could only be appropriated for programs already authorized. Following the war, subcommittees of the House and the Senate Appropriations Committees separately considered the Navy and Army defense budgets.

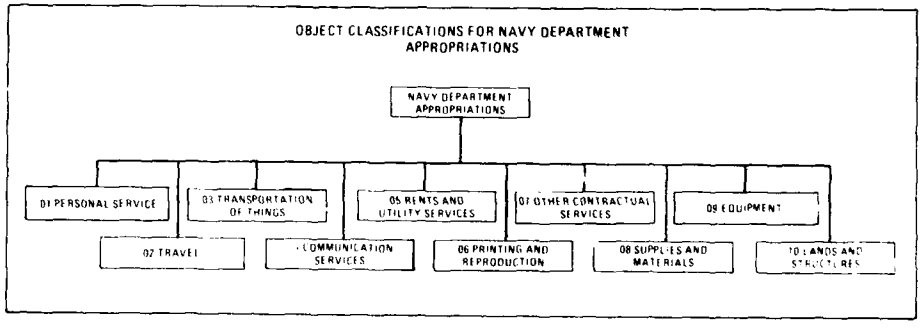
The major portion of the congressional hearings on the Navy budget was conducted on a bureau-by-bureau basis which was reflected in and paralleled by the structure of the appropriations acts themselves. After an overview of the program by the Secretary of the Navy and key assistants, each bureau chief was called in turn to justify estimates for his bureau's appropriations titles. During his appearance, he assumed major responsibility for and was the principal witness for research and development, which was presented within the context of the bureau's overall program. Occasionally he called on research and development assistants to respond to specific committee queries.

The appropriations acts by which Congress ultimately approved funds for the Navy's research and development programs defined both the legal authority and the framework of fiscal responsibility and management control. Furthermore, the form of the appropriations reflected the interaction and balance of control between Congress and the executive departments. For example, to the degree that an appropriation title was specific, Congress could influence a department's program in greater detail. Conversely, a general appropriation provided the agency named a lump-sum for various programs thus providing it more flexibility both in justifying and implementing the budget.

In 1946, the Navy appropriations structure reflected the bureau chiefs' firm hold on the department's R&D purse strings. The bulk of the funds was concentrated in lump-sum appropriations titles describing the principal activities of each bureau and office. Almost all of the department's titles were grouped under one or another of the bureaus and offices, which were specifically named in the appropriations acts and to which appropriations covering its program were assigned for administration. Within this scheme of things, research and development appeared as one of many project subheads, variously defined, in eight of the bureaus' appropriations. Exhibit IV-2 is a schematic representation of the

EXHIBIT IV-2
Navy Bureaus'/Offices' Appropriations Containing R&D Subheads
FY46 (Baseline)





* BECAME OFFICE OF NAVAL RESEARCH, AUGUST 1946

NOTE OTHER APPROPRIATIONS FOR THE NAVY DEPARTMENT FY46 WERE INCREASE AND REPLACEMENT OF NAVAL VESSELS, SALARIES, CONTINGENT AND OTHER EXPENSES, TRUST FUNDS, AND SPECIAL ACTS.

SOURCE *HEARINGS BEFORE THE SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS, HOUSE OF REPRESENTATIVES "NAVY DEPARTMENT APPROPRIATION BILL FOR 1947", 79TH CONGRESS, 2ND SESSION, PART I*

Navy Department's appropriations, showing the disparate subheads under which most research and development projects were funded.* For example, the Bureau of Ships: Maintenance appropriation contained a subhead, Project 9, entitled "Investigation and Test," with three activities, including operation of its eight laboratories and 133 research and development projects. Similarly Bureau of Aeronautics' Aviation, Navy, appropriation contained a Project 4, "Experiments and Development," with four activities including procurement of prototypes; and the Bureau of Ordnance's "Proof, Tests and Experimental Work" included seven activities, mostly defined as research.[3]

In its presentation to Congress, therefore, the research and development budget was widely dispersed, inconsistently designated, and deeply buried in lengthy justification sheets (with the exception of "Research, Navy," discussed below). The most avid congressman could not always identify the precise subheads that incorporated all the bureaus' research and development projects. Furthermore, the several elements of a research and development program were normally financed from more than one appropriation. For all intents and purposes, therefore, funds specifically designated for research and development were visible only in supporting testimony in response to direct questions from committee members. As a result, Congress effectively reviewed only fragments of the total R&D program.

The one exception to this situation was the appropriation "Research, Navy," established by Congress as a specific account to support the newly created ONR. Funded for the first time in the FY47 budget, the appropriation was initially submitted and administered by the Office of Research and Inventions, since ONR did not assume its functions until August 1, 1946. "Research, Navy" covered four activities: Research, Naval Research Laboratory, Special Devices Center, and Administration. This appropriation represented the first attempt to coordinate and fund discrete segments of the Navy's research and development program across bureau lines. At the same time, the congressional decision to permit 5-year availability of the appropriation (beginning FY48) was early recognition of the unique problems encountered in conducting research programs. Awareness of still another kind was accorded "Research, Navy" in FY47 when Congress appropriated $45 million for the program, almost 100 percent more than had been requested in the estimates.[4]

Congressional interest in reviewing the Navy research and development program as a single entity was evident in other early attempts to get correlated data of all the bureaus' research and development activities. To this end, for example, Congress often requested breakdowns of total estimated Navy expenditures for research and development and

* The "Object Classifications" shown in Exhibit IV-2 were required by Congress to correlate budget estimates across appropriations in terms of investment/resource categories. Though their importance diminished with time, Congress continued to review the budget in that context throughout the era.

occasionally, historical comparisons of expenditures or appropriations. As expenditures and technical complexity increased, so did the frustrations of trying to identify the research and development program and its potential impacts. To carry out its mandate, Congress' appetite for more detailed and comprehensive information grew correspondingly.

Executing the Navy R&D Budget

Following congressional action on the budget, the Navy Department submitted final detailed program funding requests to the Bureau of the Budget for apportioning the appropriations. While the President, and through him the Bureau, had the right to apportion the rate of commitment of appropriations over the year and to require that certain funds be held for reserves, in fact the apportionments submitted by the departments in the first half of the era were generally accepted without much question.[5]

Following the apportionment decisions, funds were officially allotted to the department and then to responsible offices and program managers according to approved operating budget programs. On the one hand, apportionment potentially provided some control to the President over the departments' obligations and expenditures; on the other hand, the Department retained some discretion and flexibility through the allocation of funds to administer its programs. This discretion was further extended by the bureau chief's broad authority to reprogram funds–virtually independent of any review–within the lump-sum appropriations designated for his bureau's program.

Because the appropriation bill reflected a budget greatly modified from the original, and because it was so long after initial program planning that estimates were no longer valid, apportionment involved a second complete iteration from working level estimates to final review by the Secretary. Noted one contemporary budget expert, "the connection between a budget estimate and the dollars actually received may be so slight as to be of little consequence."[6] For this reason, it was the final funding budget submitted to the Bureau of the Budget for apportionment decisions which became critically important to the operating levels.

The final phase of the financial management process was carried out in the comptrollers' offices. It included budget accounting, audit, and review. As indicated above, these functions will not be reviewed in this study.

SIGNIFICANT CHANGES IN THE NAVY R&D FINANCIAL BUDGET PROCEDURES 1947 - 1953

In the first decade after the war, Navy R&D budget formulation and execution continued virtually unchanged at the bureaus' working levels. During this time, however,

several changes occurred at the higher levels of review, the ripple effects of which ultimately had an impact on the entire Navy R&D financial community. The changes were triggered by the establishment and evolution of the Department of Defense.

Department of Defense

Among the provisions of the National Security Act of 1947 which established the Office of the Secretary of Defense (OSD), the Secretary was directed to supervise and coordinate preparation of the budget estimates of the National Military Establishment departments and agencies, to formulate and determine budget estimates for submittal to the Bureau of the Budget, and to supervise budget programs of such departments and agencies under the applicable Appropriation Act.[7]

This provision was the initial formal step toward coordinating and presenting a unified defense budget to Congress. Theoretically, at least, the budgets would henceforth be based on balanced national defense strategies and would eliminate duplications. The Joint Chiefs of Staff issued overall plans and force requirements to meet them; the Service Secretaries then prepared and submitted budget estimates, including those for R&D, to the OSD for review and coordination. For the first time, a single official existed below the level of President to whom Congress could address questions of overall national strategy, priorities, relevance of programs, etc.

While at least one observer considered the consolidated defense budget "one of the major benefits from the National Security Act,"[8] it had virtually no immediate impact on the actual management of the department's financial resources. To the contrary, in the late forties, the lack of any real management control over the departments by the Secretary of Defense was underscored by the National Security Act provision retaining for the Service Secretaries the right of reclama over his head:

> That nothing herein contained shall prevent the Secretary of the Army, the Secretary of the Navy, or the Secretary of the Air Force from presenting to the President or to the Director of the Budget, after first so informing the Secretary of Defense, any report or recommendation relating to his department which he may deem necessary.[9]

Congressional Committee Changes

Following the National Security Act of 1947, the separate congressional authorization committees were combined into a Committee on Armed Services in each house.

The Committees on Appropriations both followed suit with a subcommittee on Armed Services Appropriations (changed to subcommittee on Department of Defense Appropriations in 1951). These committee changes represented an early congressional move to correlate all departmental budgets and look at the defense budget as a whole. The step was somewhat reversed after the 1953 reorganization of the Department of Defense, when a Subcommittee on Department of the Navy appropriations (along with separate subcommittees for the other Services) was again created in both houses.

More significant than the changes in form of the congressional committees, however, was the modification in structure and content of the appropriations. This change marked the beginning of the shift in focus of congressional scrutiny and control.

The Performance Budget 1951

The Commission on Organization of the Executive Branch of the Government (Hoover Commission) which lent strong support to the National Security Act Amendments of 1949, had stated unequivocally that "the military budget needs a major overhaul." Nevertheless, fiscal provisions of the 1949 Act were added only as an amendment to the original bill.[10] Among the significant changes brought about by that amendment, known as Title IV, were the introduction of the Department of Defense Performance Budget, the establishment of comptroller organizations throughout the department, and the granting of additional authority to OSD in the budget process. While the objectives and impact of these changes far transcended R&D financial budgeting, the Performance Budget was a milestone in the environment within which the research and development budget structure and management subsequently evolved.

Fundamentally, the Performance Budget represented an effort to rectify the most glaring deficiencies in the current procedures by which budgets could not be related to objectives and programs, and a single project was financed in several appropriations, for which different organizational units were administratively responsible. The effect of this diffusion was to obscure the relationship between content and cost of discrete projects or programs; it was very difficult for Congress to correlate planned military activities and capabilities with appropriations requested. From the management point of view, the budget structure did not correspond to areas of administrative responsibilities; review and assessment of economy and efficiency were also somewhat inhibited by the relation of budget items to supplier/producer rather than to consumer.

The basic principle on which the Performance Budget was conceived was that expenditure proposals should be made in terms of the objectives they were intended to further (programs, functions, activities) rather than the class of items they would acquire

(services, supplies, etc). Insofar as it was possible, an attempt was made to devise budget programs that also conformed to administrative decisions and reflected uniformity among the Services.

To these ends, Section 403(a) required structuring the budget along program lines (although other classifications were not excluded):

> The budget estimates of the Department of Defense shall be prepared, presented, and justified, where practicable, and authorized programs shall be administered, in such form and manner as the Secretary of Defense, subject to the authority and direction of the President, may determine, so as to account for, and report, the cost of performance of readily identifiable functional programs and activities with segregation of operating and capital programs.[11]

Due to the complexity and magnitude of converting to the new budget structure, and because preparation of the FY51 budget was already well under way, full implementation of the Performance Budget was not achieved until FY52.

Within the Navy Department, the Performance Budget was effected by grouping together related program components under 21 appropriation titles (cf. 77 in FY46). The new appropriations were still structured along the lines of bureau management responsibility. For the first time, however, the bureaus were *not* mentioned by name, although the bureau chiefs still justified their estimates up through all the budget and review levels, including Congress.

Another innovation in the new budget structure was the appearance of "Research and Development" as a uniform subhead or budget activity in nine of the appropriations. Included under this subhead were all direct costs for performance of R&D projects, e.g., contracts with nongovernmental agencies, civilian personnel, materials, and minor equipment utilized at naval activities. Indirect costs were those defined as all overhead costs at Navy research and development laboratories and testing stations and were budgeted under a maintenance and operations subhead.

From a management point of view, therefore, the responsibility for R&D as a distinguishable program, funded from a single source, was now more clearly fixed. For program planning and review, however, the program was still only partially visible since [illegible] the R&D funds (i.e., only the direct cost of the program) were subject to program [illegible] by the Navy Research and Development Review Board and the Research and [illegible]ment Board.[12]

The bureau orientation of the Navy Department's budget also implied a somewhat different structure than that devised by the other Services, which conformed to general staff activities. It was the Air Force and Army structures that were ultimately used as the basis for the first overall defense budget classification system. Introduced in the FY53 Presidential Budget, it aggregated budget activities according to major cost categories. The objective was to facilitate Department-wide comparison of budget estimates by OSD. Within this scheme, Category VI was designated "Research and Development;" it included all costs, direct and indirect, for the R&D programs of the three Services.

In retrospect, the overall effect of Title IV and the Performance Budget was to initiate a trend toward establishing an appropriation structure based on programs to be performed rather than supplies to be acquired. The effect on R&D financial management specifically was to provide uniform subheads for the bureaus' R&D programs, funded through a single appropriation. What the Performance Budget failed to do was enhance any systematic review of past budgetary performance since the auditing functions of the GAO continued to be directed toward compliance with the law rather than the promotion of efficiency.[13] In addition, while the new budget structure was a great improvement in indicating what funds would achieve, it neither revealed the degree of preparedness and relative mix of defense forces nor served the requirements of administrative management, i.e., to judge effectiveness of different organizational units within a department.

Fiscal Year 1951 also saw a significant change in funding availability for the appropriation, "Research, Navy." Following a request by the Department of the Navy during its appropriation hearings, a provision in the final Appropriation Act changed the "Research, Navy" funds from 5-year availability to "no-year" funds, i.e., good until expended, or the equivalent of continuing appropriations. R&D funds contained in the subheads continued to be appropriated for expenditure over a 3-year period.

OSD and Navy Comptrollers

In addition to the changes brought about by the imposition of the Performance Budget, Title IV contained several other provisions that affected the budget process. The most immediately obvious was the establishment in OSD of an Office of the Comptroller to act as the Secretary's principal fiscal advisor and management officer. His duties included not only supervision and direction of the preparation of an integrated military budget, but also establishment and supervision of principles, policies, and procedures for the preparation, execution, and auditing of the department budget.

Once the entire Navy budget, including provisions for R&D, was approved by the Secretary of the Navy, it was forwarded to the Research and Development Board for

program review and then to the OSD Comptroller for his "markup." This was carried out within the context of the entire DOD budget and on the basis of the Board's recommendations. Technically, the budget was then approved by the Secretary of Defense and sent to the Bureau of the Budget for further hearings and markup. Because of their "community of interest," the time involved and staffing difficulties, the DOD Comptroller and the Bureau of the Budget usually reviewed the departmental budget together. "While much of the review [was] concerned with the detail that encumbered the departmental budgets, the Comptroller and the Budget Bureau. . . necessarily had to concern themselves with matters of highest policy,"[14] especially when large cuts were made.

In effect, Title IV introduced a third entity–the Comptroller–into the policy process. "He, rather than the Services, shared the Secretary's authority (and) came between the service departments and the Secretary."[15]

Title IV also required establishment in each Service of its own Comptroller who would assume direct responsibility for the budget, although ultimate legal responsibility remained with the civilian secretary. In the Navy, the Office of the Comptroller was assigned to the Assistant Secretary of the Navy (Air), who happened also to have responsibility for Navy R&D.* Most of the budgeting and other comptroller work at the department level was actually carried out under the direction of a deputy, a naval officer who worked closely with the Office of the Chief of Naval Operations. After considering recommendations of the Navy Research and Development Review Board, the Navy Comptroller marked up the Navy budget (of which R&D was a part) and sent it on to the Navy Secretary for approval. The Office of Budgets and Reports continued its functions as a budget review agency for the Secretary. In addition, a Budget Advisory Committee, which consisted of top ranking officers from the operating bureaus, brought its views to bear on major features of the department budget. Since most major decisions had been made previously by the Chief of Naval Operations, however, the Committee's impact was minimal.[16] By 1953, Comptroller organizations had been established in all the bureaus, headquarters, offices, and field activities.[17]

Significant effects of the establishment of the DOD Comptrollers were the addition of another review level to the budget process, the increase in time lags, and the dilution of the authority of program managers and the civilian secretary over budget decisions. As one contemporary expert on the federal budget observed:

> He [the civilian secretary] is surrounded by a budgetary staff that is almost entirely military with responsibility to the military command rather than to him [and] his influence must be exerted on a process

* Following the Gates Report, 1954, the Comptroller's billet was established as a full-time civilian job, reporting to the Under Secretary of the Navy.

> that has already been taking shape for over a year. . . When the secretary receives the budget, it has been approved by the committees (Budget Advisory Committees) and by the Chief of Staff (CNO) and he may have little but to transmit it to the Secretary of Defense.[18]

Restrictions on Appropriated Funds

The authority of the Secretary of Defense over the entire department's financial management process was enhanced in at least one important respect by another 1949 Amendment provision. Seeking to prevent the widespread practice of overdrafts and deficiencies, the Amendment required that the Secretary of Defense approve scheduled rates of obligation of funds appropriated to the departments. Although this was not intended to interfere with the internal administration and allotment procedures of the appropriation, it provided the basis for the Secretary's future authority to make deferrals regularly.

A year after the 1949 Amendments, the general Appropriation Act also affirmed the authority of the President and the Bureau of the Budget to establish reserves for contingencies or savings through the apportionment process.[19] While legal authority to withhold appropriated funds had existed since 1921, in fact, the Budget Bureau had normally approved apportionments proposed by the departments without much question. The new emphasis not only created still another lengthy review process, but also further diluted the authority of the department program managers over their funds and injected additional uncertainty into the funding process.

Notes to Chapter 12

1. Bureau of the Budget, Circular 49, December 19, 1921 (subsequently elaborated by circulars A-9 and A-19 issued in 1948), cited by Arthur Smithies, *The Budgeting Process in the United States* (New York, 1955), pp. 74-75. (Professor Smithies, Chairman, Department of Economics, Harvard University, conducted this comprehensive, analysis for the Committee for Economic Development.)

2. U. S., Congress, House of Representatives, Committee on Naval Affairs, *Sundry Legislation Affecting the Naval Establishment Hearings*, 79th Congress, 2nd Session, 1946, pp. 2764-2766.

3. U. S., Congress, House of Representatives, Committee on Appropriations, *Navy Department Appropriations Bill for 1946, Hearings*; 79th Congress, 1st Session, 1945, Part 1.

4. "Research, Navy, Budget Estimates FY1947," ONR Files.

5. Smithies, *Budgeting Process*, op. cit.

6. Smithies, *Budgeting Process*, p. 247.

7. P. L. 80-253, Section 202.

8. Charles H. Donnelly, *U. S. Defense Policies Since World War II* Library of Congress Legislative Research Service, House Doc. 100, 85th Congress, 1st Session, (Washington, D.C., 1966), p. 63.

9. P. L. 80-253.

10. Commission on the Organization of the Executive Branch of the Government (First Hoover Commission), *Report to the Congress, The National Security Organization* (Washington, D.C., February 1949), p. 5; John C. Reis, *The Management of Defense* (Baltimore, 1964), p. 128.

11. P.L. 81-216, Section 402-407.

12. OPNAV Instruction 0390.1, Subject: Coordination of Research and Development, May 25, 1951.

13. Smithies, *Budgeting Process*, p. 25.

14. Ibid., p. 255.

15. Reis, *Management of Defense* p. 129.

16. Smithies, *Budgeting Process* pp. 252-254.

17. SECNAV Instruction 5400.4, Subject: Establishment of Comptroller Organizations in Bureaus, Headquarters, Offices, and Field Activities of the Navy and Marine Corps from Secretary of the Navy to all Ships and Stations, November 19, 1953.

18. Smithies, *Budgeting Process* pp. 252-254.

19. P. L. 81-595, Statute 64, Section 1211, cited by Smithies, *Budgeting Process* p. 150.

CHAPTER 13

EVOLUTION OF THE RDT&E,N APPROPRIATION 1953 - 1960

The creation of a separate appropriation for defense research and development was generated in part by the forces of DOD unification and the accompanying drive to establish centralized control over R&D. It was also indicative of growing recognition that research and development was a sizable and separable defense activity which represented only the tip of the weapons system procurement and operations iceberg. Before the end of the decade, a concerted effort by OSD and Congress to identify, review, and control the total program and its cost had led to the establishment of the appropriation "Research and Development, Navy" and its subsequent expansion to include related test and evaluation costs.

ESTABLISHMENT OF THE "RESEARCH AND DEVELOPMENT, NAVY" APPROPRIATION

The process of establishing a Navy-wide R&D account began in the early 1950's when OSD established major cost categories—of which Research and Development was one—incorporating all comparable programs across Service lines. DOD used the structure for presentation of the President's budget and again during the defense appropriations hearings. Congress readily accepted it as a means to determine quickly total defense costs and yearly changes in the various budget activities. By FY52, Congress had established a single R&D account for both the Army and the Air Force.

The 1953 defense reorganization and creation of the Office of the Assistant Secretary of Defense (R&D) provided further impetus to initiate a Navy R&D appropriation. The new office put pressure on the military departments to identify their R&D programs in increasing detail in order to facilitate guidance and direction from the OSD.

The Navy Department resisted the trend toward a Navy-wide R&D appropriation; more specifically, the still-strong bureaus resisted any erosion of their authority and control over research and development. As one contemporary participant noted, "If the Navy could have had a single appropriation, but retained complete control with no outside direction. . . that would have been all right."[1]

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The bureaus' concern about losing control over Navy R&D if the OSD were to become too involved was symbolized in the argument that a single appropriation would "complicate" the process and increase paperwork. OSD, on the other hand, saw a single R&D appropriation as a means of reducing both. Congress eventually imposed the change.

Congressional Motivation to Establish "R&D, Navy" Appropriation

In addition to OSD pressures to standardize budget categories across Service lines, some Congressmen were becoming increasingly frustrated trying to review the Navy's R&D program. During the FY54 appropriations hearings, the subcommittee chairman, Congressman Richard B. Wigglesworth, admitted that they could not really penetrate the R&D program, partly because R&D funds did not appear in one place but were dispersed in nine different appropriation items. In addition, he noted:

> The difficulty that always confronted the committee is the difficulty of not knowing where to draw the line. . . Our investigative staff are of the opinion. . . that there is heavy overfinancing and room for real economy in respect to projects undertaken. . . My impression is that the research and development program, as important as it is, needs a thorough going over from an across-the-board standpoint in order to determine what is essential and what is not essential. . . For years we have hardly touched research and development. . .[2]

Symbolic of the anomalies that had resulted from the fractionation of the R&D money was the recent congressional attempt to cut the Navy's R&D expenditures by reducing the "Research, Navy" appropriation by $10 million; instead of distributing the cut throughout the R&D program, it had been effected entirely in ONR's budget.

Navy Arguments Against "R&D, Navy"

During the FY54 hearings, Congress requested the Navy to provide tables of the Navy R&D obligations and requests broken down in several different ways.[3] Departing from past practice, top R&D officials, including the ASN(Air), DCNO(Air), ACNO (Readiness), CNR, and others, made a special presentation of the Navy's overall R&D program. In the course of the hearings, they strongly emphasized that the distribution of R&D funds among the bureaus' appropriations corresponded to the Navy's effort "to accomplish the research and development work in an effective manner. . . In reviewing this work, it is necessary, first, to examine our organization if you are to understand the reasons behind our appropriation structure."[4] In one plea to retain the current structure, Rear Admiral Clexton, Director of Budgets and Reports, noted that:

> Funds provided for the Navy by the Congress are based on approved Navy programs and are given under an appropriation structure best designed to fit the needs of Navy management in the execution of these programs. . . I feel that it is because of the sound appropriation structure of the Navy which has been provided by the Congress, the Navy management system, and the supplementary accounting system that we have been able to provide this committee quickly with accurate, timely information in support of our programs and our requirements for funds.[5]

"R&D, Navy" Established

Notwithstanding, the following year Congress consolidated all R&D line items of the nine bureaus and offices concerned (including "Research, Navy") into a single continuing, i.e., "no-year," appropriation. "Research and Development, Navy" was formalized and first presented in the FY56 budget.

Simultaneously, ASD(R&D) Donald A. Quarles, working with the Bureau of the Budget, introduced a uniform end-item breakdown of the R&D appropriation to facilitate evaluation and comparison of the three Services' research and development programs. Accordingly, all individual projects in the Navy's R&D program were classified by end object into one of the following budget activities:

- Aircraft and related equipment
- Guided missiles and related equipment
- Ships and small craft and related equipment
- Combat and support vehicles and related equipment
- Artillery and other weapons and related equipment
- Ammunition and related equipment
- Other equipment
- Military sciences
- Operations and management of facilities.

For internal DOD purposes, all programs were classified in still another system which placed emphasis on military missions/operations, e.g., antisubmarine warfare, air defense, and amphibious operations. While this latter structure was not specifically requested by Congress, OSD required the Navy to prepare R&D estimates in those terms, as well as by end object, and witnesses had to be available to discuss them during congressional hearings.

ONR Designated Responsible Office

Establishment of the new Department-wide R&D appropriation created a corresponding need for a central fiscal coordination/administration office. Immediately following the FY55 congressional hearings, the Secretary of the Navy assigned to the Chief of Naval Research (CNR) the responsibility for preparing and submitting the consolidated R&D budget to the ASN(Air).[6] The following year, SECNAV designated ONR the responsible office for the "R&D, Navy" appropriation, reporting directly to the Secretary of the Navy.

The assignment of management responsibility to ONR was partly an extension of that office's responsibility for the appropriation "Research, Navy" and partly an outgrowth of the recent assignment to ONR of coordinating responsibility for both research and development. The immediate result of the action was to increase the total volume of funds accounted for by ONR from approximately $60 million to approximately $430 million. Some R&D managers viewed the ONR assignment as an inherent conflict of interest, since the CNR competed for R&D funds along with the other bureau chiefs.[7]

While the assignment involved primarily comptroller-type functions, rather than decisionmaking authority, it also carried with it legal responsibility for administration and control of the money[8] that flowed from the Bureau of the Budget down through the Navy Comptroller to ONR, and which ONR passed on to the bureaus. By implication, the CNR, through the ONR Comptroller Office, could influence allocation decisions; but in fact, CNR did not often attempt to assert any budgetary authority.[9] Because the R&D appropriation was the first Navy-wide account for which essentially all Navy bureaus and offices were assigned administering responsibility, the allocation and accounting system that ONR developed served as a pattern for other overall appropriations established later.

Impact of Establishment of a Single R&D Appropriation

The immediate result of the new R&D appropriation structure was a complex and voluminous budget submission. For several years the Navy R&D budget request was prepared according to the new DOD classification system superimposed on the old bureau

subdivision. One practical result was a sizable Navy R&D contingent at the congressional hearings. The first year, no less than 27 people appeared as witnesses to justify the first R&D,N appropriation: the ASN(Air), James H. Smith, Jr., was accompanied by all the bureau chiefs and their respective assistants for R&D. The dual submission was due not only to the innate resistance to changing long-established traditions, but also to the realities of Navy organization and management and control practices. Noting the many significant changes in the Navy system for financing and administering its R&D program during the past year, for example, the Chief of Naval Research, Rear Admiral F.R. Furth, underscored the continuing focal point of management responsibility:

> This change in appropriation structure has not taken away the responsibilities of the individual bureaus and the Marine Corps for the preparation and execution of their assigned portions of the research and development program. They will continue to prepare the basic budget estimates and perform the detailed accounting therefore.[10]

The interrelationship between the bureau activities and the new DOD end-item breakdowns is shown in Exhibit IV-3.

If initially the bureaus' well-established authority over the R&D program within their purview did not seem greatly modified, as time went on the new appropriation had some far-reaching effects on Navy R&D management. First, within the context of the first Navy-wide account, all of the bureaus' R&D programs had to compete more directly for funds. Second, the identity of the individual bureaus was somewhat subordinated. Finally, the need to coordinate budgets and funding distribution from a single account created the potential for greater guidance, review, and decisionmaking at the secretarial level and higher, i.e., OSD, BuBud, and Congress. This potential was ultimately realized.

The single R&D, Navy account was thought by many R&D managers at the bureau level to mark the inception of a trend--the first "irreversible violation" of beginning-to-end responsibility for managing R&D programs in the bureaus.[11] Others realized that the single R&D appropriation considerably simplified the R&D managers' tasks in preparing and presenting the R&D budget, since there was only one set of hearings and one appropriation to justify.

From the top-level reviewers' point of view, a fiscal management budget by which BuBud,OSD, and Congress could review the Navy R&D program as an entity now existed for the first time. Among other things, it permitted the congressional appropriations subcommittee to observe that the Navy was getting a greater share of the DOD R&D funds than it had previously.[12] At the same time, committeemen noted "slippages" in identifying and including in the new appropriation all activities supporting the R&D

EXHIBIT IV-3
Relationship of R&D Navy Appropriation End-Item
Programs and Budget Activities By
Management Organization FY56

Navy R&D Management Organizations \ Defense R&D Programs	Aircraft and Related Equipment	Guided Missiles and Related Equipment	Ships and Small Craft and Related Equipment	Combat and Support Vehicles and Related Equipment	Artillery and Other Weapons and Related Equipment	Other Equipment	Military Sciences	Operation and Management of Facilities*
Aviation	•	•	•		•	•	•	•
Ships		•	•		•	•	•	
Ordnance	•	•	•	•	•	•	•	•
Medicine						•	•	
Civil Engineering						•	•	•
Supply			•			•	•	
Naval Personnel							•	
Marine Corps		•	•	•	•	•	•	
Naval Research	•	•	•		•	•	•	•

*O&M becomes separate appropriation FY57.
Source: Justification books submitted to Congress FY56 ONR Comptroller Office

program. For example, recurring expenses in R&D facilities, patents, military personnel costs, operation of ONR, procurement of R&D equipment, etc., were not included in the new appropriation. The degree to which identifiable R&D costs, e.g., activity and procurements supporting R&D, were programmed in other appropriations was actually considerable. For example, the R&D,N appropriation for FY55, FY56, and FY57 covered only 63 percent, 52 percent, and 38 percent, respectively, of the total costs which could be directly related to the R&D program.[13] A campaign to rectify this situation by "purifying" the appropriations involved was thereby launched; it continued to the end of the era.

EXPANSION OF THE R&D,N APPROPRIATION TO RESEARCH, DEVELOPMENT, TEST, AND EVALUATION (RDT&E,N)

The 1958 Defense Reorganization Act, and particularly the creation of the Director of Defense Research and Engineering (DDR&E), had significantly affected not only the formal structure of the R&D,N appropriation, but also the management and control of the account. With the advent of changes in DOD organization, Congress' attempts to "purify" R&D,N and related appropriations, begun almost immediately, were stepped up and became part of a broader effort to revise the entire defense department appropriation structure. Triggered by the requirement in Title IV of the 1949 Amendment Act for comparability and uniformity in the Services appropriations, OSD (Comptroller) and BuBud focused considerable attention on defense budget reform. The 1958 Reorganization Act introduced a sense of urgency into the issue, however, especially with respect to the R&D budget, since the newly designated DDR&E had jurisdiction over the entire defense R&D spectrum including test and evaluation. The implication for detailed control over R&D, on the one hand, and the extension of R&D management circles to include T&E personnel, on the other hand, were not lost on Navy officials.

Proposals for Revising the R&D Appropriation Structure

In the summer of 1958, to forestall imposition and changes from above, the Department of the Navy began looking at the structure of its appropriation accounts, which still differed somewhat from that of the other military departments. It had "been the subject of comments and discussions by higher authorities for some time," noted the Navy Comptroller. Recognizing the impending changes that would inevitably issue from the defense reorganization, NAVCOMPT requested comments on a possible consolidation of the 21 Navy appropriations into "six category-type appropriations which might be the most practical answer if this Department were directed to adhere to the requirements of legislation and DOD plans in this area."[14]

Among the six accounts proposed was one entitled "Research and Development," which would be retained essentially as it was in terms of both administration and format. Before any internal change could be made, however, DOD and the BuBud preempted the initiative with proposals to make sweeping revisions in the whole defense appropriation structure.

In the fall of 1958, the Assistant Secretary of Defense (Comptroller), the Bureau of the Budget, and the House Appropriations Committee held a series of discussions on revision of the defense budget structure necessary to implement the intent of the recent reorganization. Among the proposals urged by the Defense Comptroller and the BuBud was the substitution of the current Service-oriented titles in the defense appropriations

acts by eight activity-oriented titles reflecting the way the Department as a whole managed its resources.* Title V was to be designated "Research, Development, Test, and Evaluation." The original idea was to consolidate into a single appropriation for the entire Department of Defense all those funds currently in procurement appropriations which related specifically to test and evaluation and all those funds in maintenance and operations appropriations (also to be pulled together into one account) which related to R&D projects.[15] Congressional committee members initially resisted the consolidated appropriation because it would tend to present them with program decisions made at the Secretary of Defense level, thus depriving Congress of the opportunity to choose between options presented by the responsible operating elements of the several Services.

Navy Reaction to the Proposed Changes

The new appropriation structure was scheduled for discussion at the forthcoming meeting of the Armed Forces Policy Council. Preparing for a "composite Department of the Navy position," NAVCOMPT solicited inputs from all bureaus and offices. Comments on the proposed modification to the R&D appropriation varied. The Chief of BuAer, Rear Admiral R. E. Dixon, noted that the Navy was currently organized to fix accountability for administration of funds directly in the bureaus and offices that justified their budgets to Congress. The consolidated appropriation would not only compromise this management principle, but also increase the appropriation by 100 percent, giving Congress the impression of an "adverse relationship between the defense dollar invested in research as against hardware." He predicted the net result would be R&D appropriations well below those requested. Furthermore, combining test and evaluation with R&D into one account would eliminate current flexibility between evaluation and procurement which permitted reinvestment of funds from evaluation failures into production of proven equipment.[16]

Rear Admiral A. G. Mumma, Chief of the Bureau of Ships, maintained the new RDT&E appropriation would impose additional and cumbersome review and approval procedures, inhibiting the ability to take advantage of technical advances by reprogramming, and also removing vital detailed decisionmaking from technical knowledge and

* The eight titles were:
Title I - Military Personnel
Title II - Operations and Maintenance
Title III - Procurement and Production
Title IV - Military Construction
Title V - Research, Development, Test and Evaluation
Title VI - Interservice Activities
Title VII - Revolving Funds
Title VIII - General Provisions

responsibility for results. Furthermore, its size would make the appropriation a "prime target for cutbacks regardless of the merit of its constituent programs."[17] Rear Admiral Withington, Chief of the Bureau of Ordnance, was also strongly opposed to the proposed change.

For his part, the CNR, Rear Admiral Rawson Bennett, opened his comments with the following statement:

> Since the centralization of all R&D funds in one appropriation at the DOD level is contrary to all accepted theories of modern management, particularly those of modern research management, the reason for this shift in current appropriation structure must be to put complete control and direction of the R&D programs in the hands of the Director of Research and Engineering. While this is contrary to the testimony of the Secretary of Defense and his staff when justifying the DOD Reorganization Bill before the committees of Congress, no other reason for this shift is apparent.[18]

Furthermore, the CNR pointed out that the proposed change would severely complicate and lengthen the whole financial management procedure and require a new accounting procedure to provide for an additional split of funds. Rather than increasing efficiency, accuracy, or timeliness of fiscal operations, this would add to their cost, delay, and confusion. Nor did Admiral Bennett foresee improvements in the budgetary process. Preparation of supporting data for the R&D budget would continue to be prepared by the three Services under a new single appropriation, and in addition, all of the other work for a budget submission to Congress would have to be duplicated at the DOD level with an augmented staff. Then, only the most general presentation could be made at future budget hearings if Congress did not want to conduct hearings on the floor of the House to accommodate the many Service witnesses. "It seems fairly obvious," concluded Bennett, "that improvement in the budgetary process is not the reason behind the creation of a single DOD Research and Development appropriation." He noted that from OSD's point of view, the single R&D appropriation would provide additional flexibility in shifting funds and programs between Services. But current authority already made $150 million available for that purpose. "It is difficult to imagine what types of recurring shifts in program would require a greater authority than this amount represents," he wrote. Admiral Bennett also reiterated the contention that the dollar levels reported for R&D in the new appropriation would startle reviewers and likely result in appropriation cuts. Finally, Bennett summed up his major conclusion:

> The whole purpose for the shift in appropriation structure must be found in the desire to provide a centralized control of the funds for R&D and the technical makeup of the R&D program by a single staff

evaluation items, (e.g., missiles, aircraft, and/or facilities for production), would be identified and considered for inclusion either in separate budget projects under procurement and production or under RDT&E.[23] In addition, to ensure comparability between the Services' programs, all items in the RDT&E appropriation were to be coded into eight categories corresponding roughly to the end-item (budget projects) classification already in use.

Immediate Impact and Reaction to the Changes in the Navy Department

From the Navy R&D management point of view, the reaction to and impact of the new appropriation was mixed. The Office of the Chief of Naval Operations [as represented by Rear Admiral J. Hayward, the Assistant Chief of Naval Operations (Research and Development)] was positive. In a memorandum to the CNO, December 9, 1958, Admiral Hayward enumerated his views concerning the effects of the new budgetary procedure:

> R&D in the Navy should receive a tremendous impetus. It will become really big business - the true amount of the necessary cost of development of new items will be faced up to. . .
>
> The CNO's capability to coordinate and direct the efforts of the bureaus to effectuate the availability of newly developed equipment and material will be greatly enhanced; great flexibility will result. Bureau decisions involving large sums in reprogramming will be more readily subject to CNO knowledge and concurrence. . .
>
> Several echelons of budgetary reviews that plague the Navy R&D program will be eliminated. The Material Bureaus will initially resist the full and complete application of this new procedure. Past procedures and habits are too long engrained - they will fear for their prerogatives and the too close scrutiny of the CNO in their development and production programs. . .
>
> Much opposition will stem from comptrollers and contract people against prompt or complete adherence to the new policy because of the acknowledged large bookkeeping and accounting task involved.
>
> The new 'honest' procedure will be forced on the DOD by the Congress eventually if a 'drag-the-feet' approach is taken.
>
> Finally, the overall Navy R&D program should be aided greatly in achieving the ultimate goal of producing acceptable service hardware

> designs of new and improved weapon systems and weapon system components in time to add to the Navy's combat readiness - not too little nor too late.[24]

Admiral Hayward's analysis of the bureaus' likely reactions was largely correct and consistent with their earlier representations to the NAVCOMPT. Even though at this point the RDT&E appropriation was an established fact, there was some attempt on the part of the bureaus to soften or slow the pace of its implementation due either to inertia or to very real problems with which they were faced.

The most immediate problem was the mechanical task of revising the complex schedules in less than a month, when the FY60 budget would be printed. ONR, which was faced with a gargantuan task of coordinating and preparing the budget presentation in a new format, tried to delay full implementation of the new structure.[25] The time constraints of the FY60 budget preparation under the new appropriation structure were further exacerbated by the very real problem of the several methods used to identify and classify R&D projects. For submissions in the planning and programming phases, for example, CNO had also just adopted the three-part program classification described in Chapter 10. Submissions to and markup by the Naval Research and Development Review Board were made on this basis. To satisfy budgetary requirements (i.e., with Comptroller-type submissions, including budget justifications and apportionment requests) each R&D project was also classified on the end-item ("DOD class") basis. Both sets of classifications were further described by Navy bureau and office. From an accounting point of view, the appropriation still had to be prepared for the Congress by object classifications as well. Finally, classification and identification of R&D projects were required according to DOD operational categories;* type of research (basic research, applied research, development, and T&E); and special codings for materials research projects, ASW projects, and oceanography projects.

A more fundamental problem than the mechanical difficulties, and one discerned immediately by those involved, was defining the new RDT&E appropriation, i.e., the substance of the drive toward "purification." Generally, the problem was one of identifying all those items considered part of the R&D cycle; more specifically, the major issue was in differentiating between development and procurement. As a purely technical matter of definition, it was difficult enough to determine where development stopped and procurement began, e.g., "Is the line drawn before or after prototype production?" BuAer, for one, strongly urged that Navy take a very "conservative approach" in defining

* Operational Categories (required by Supplement 1 to DOD Instruction 3200.6 of 1 March 1960) AD - Air Defense Operations, SA - Strategic Operations, TA - Tactical Air Support Operations, AO - Amphibious Operations, UW - Undersea Operations, SC - Sea Combat Operations, LC - Land Combat Operations, SO - Support Operations, AR - Applied Research, BR - Basic Research, MS - Management and Support.

the type of costs that should be transferred from Production and Procurement to RDT&E primarily because "Procurement of complete aircraft is most properly funded in P&P since the end product is an operational piece of equipment which under firm program scheduling has been built on production tooling."[26]

BuAer's point is illustrative of the types of problems and resistance encountered by both Congress and the Services in attempting to define the RDT&E appropriations. Fueling the issue was the R&D managers' deep fear of incursion of T&E into available funds for R&D. The inclusion of T&E seemingly increased absolute dollars spent for R&D, but inherently greater costs for development and T&E might serve to reduce the proportion of funds spent on the R&D end of the spectrum. While funding for a prototype aircraft "didn't make much of a dent" in the sizable "Procurement of Aircraft, Navy" (POAN) appropriation, for example, its share of the much smaller R&D appropriation would be considerable. Furthermore, a sharp incline in the R&D funding chart as a result of including T&E might dull arguments in Congress that programmatic expansion of an activity required more funds; it might also induce Congress to make cuts in R&D funds, *per se*. These concerns were reflected in some R&D managers' later observations that the overall impression in the first year of the RDT&E appropriation was that the Navy had *lost* 30 percent of its R&D budget.[27]

As a practical matter, many of the pessimistic predictions of an expanded appropriation proved unfounded, although the accumulation of subsequent events ultimately contributed to the feeling that the predicted had indeed occurred. The RDT&E,N budget submission to Congress in FY60, the first year of the expanded appropriation, was $971 million; congressional action resulted in an appropriation of almost 5 percent above the request (cf. an increase of more than one percent in the total Navy budget).[28] To put this clearly in perspective, changes made by Congress in the effective funds appropriated for R&D in the 4 years from FY50 and FY53 amounted to reductions of 0.4 and 0.7 percent in 2 years and increases of 0.3 and 1.5 percent in the other 2 years.*[29]

Projecting ahead to the outcome of another concern, it will be seen that the percentage of funds allocated to the early phases of RDT&E (i.e., R&D versus T&E) did, in fact, decline after 1958. Data presented in Chapter 14 indicate, however, that this decline could have been attributable as much to the proliferation of large programs, Special Project Offices (of which the Polaris SPO was the prototype), and what some called "sacred cows" as to the incursions of T&E.

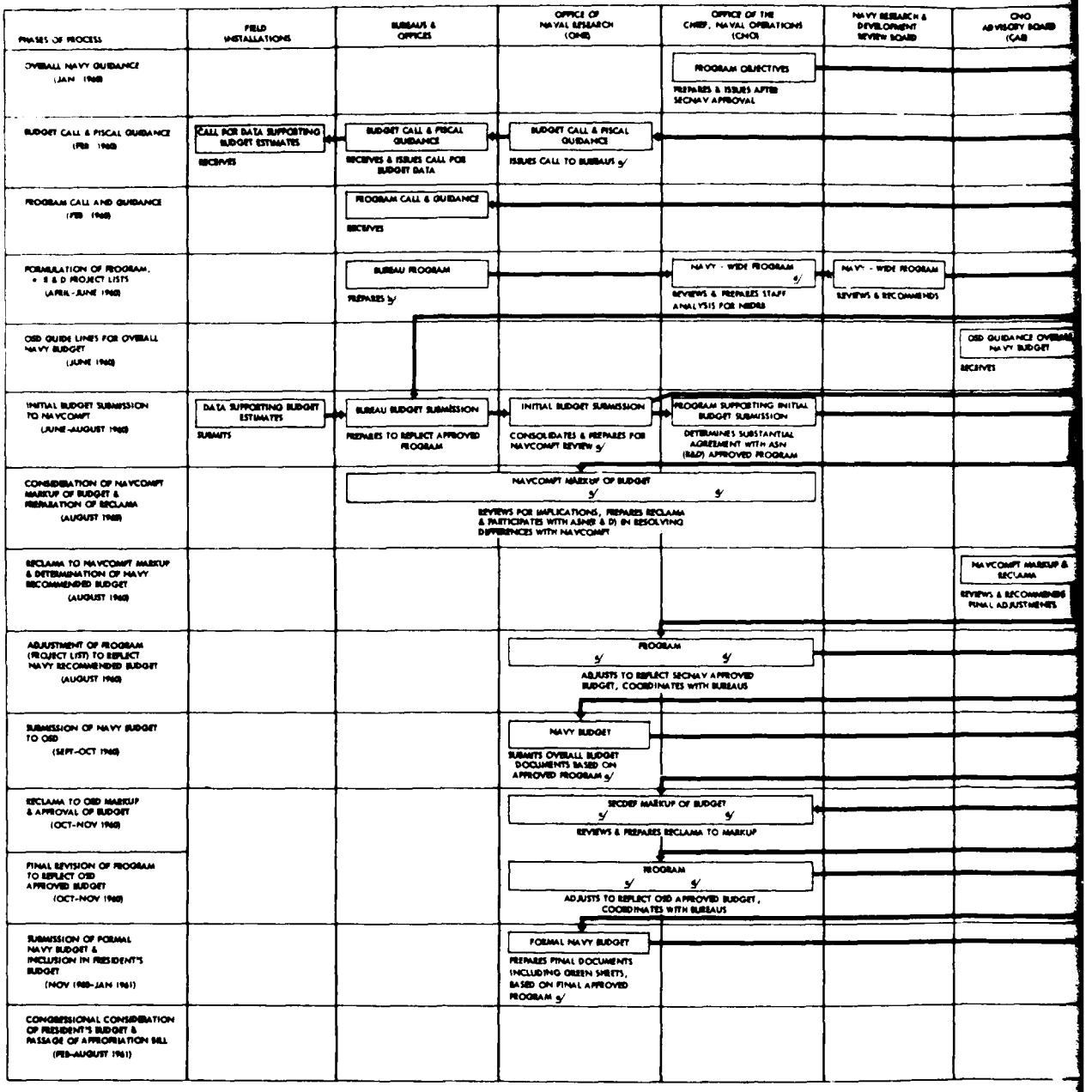
On the other hand, budget formulation did become more complex, time consuming, and subject to reviews. The annual RDT&E program and budget formulation process for Fiscal Year 1962,depicted in Exhibit IV-4,indicates the considerable increase in steps and review levels compared to 1946. This was generated not only by increased technological

* For a presentation of congressional changes in the R&D budget requests from FY55 to FY74, see Exhibit IV-16 in the Summary to Part IV.

complexity and correspondingly larger numbers of R&D managers, but also by the addition of the managers and the accompanying growth of coordination, documentation, and paperwork.

The early struggles to define and "purify" RDT&E,N and related appropriations foreshadowed the subsequent, almost annual, series of transfers in and out of the account. Exhibit IV-5 details the evolution of the definition of the RDT&E,N appropriation. As indicated, the major transfer of T&E items was effected in two increments, FY60 and FY61; but transfers from various accounts were made in almost every year up to and including FY74 and beyond.

Finally, the significance of the creation of the RDT&E,N appropriation lay not so much in its immediate impact on Navy R&D management, but rather in its early manifestation of the trend toward increasing complexity and growth of R&D accompanied by progressive centralization of defense R&D decisionmaking in the Office of the Secretary of Defense. In this, the initial reaction of Chief of Naval Research Bennett proved correct.



a/ PERFORMS FUNCTION AS COMPTROLLER FOR THE R, D, T & E APPROPRIATION ON BEHALF OF ASN(R & D).

b/ DECIDED BY DEVELOPMENT OF PROGRAMS FOR INDIVIDUAL LABORATORIES, DETERMINED ON BASIS OF INPUT FROM & CONFERENCE WITH SUCH LABORATORIES.

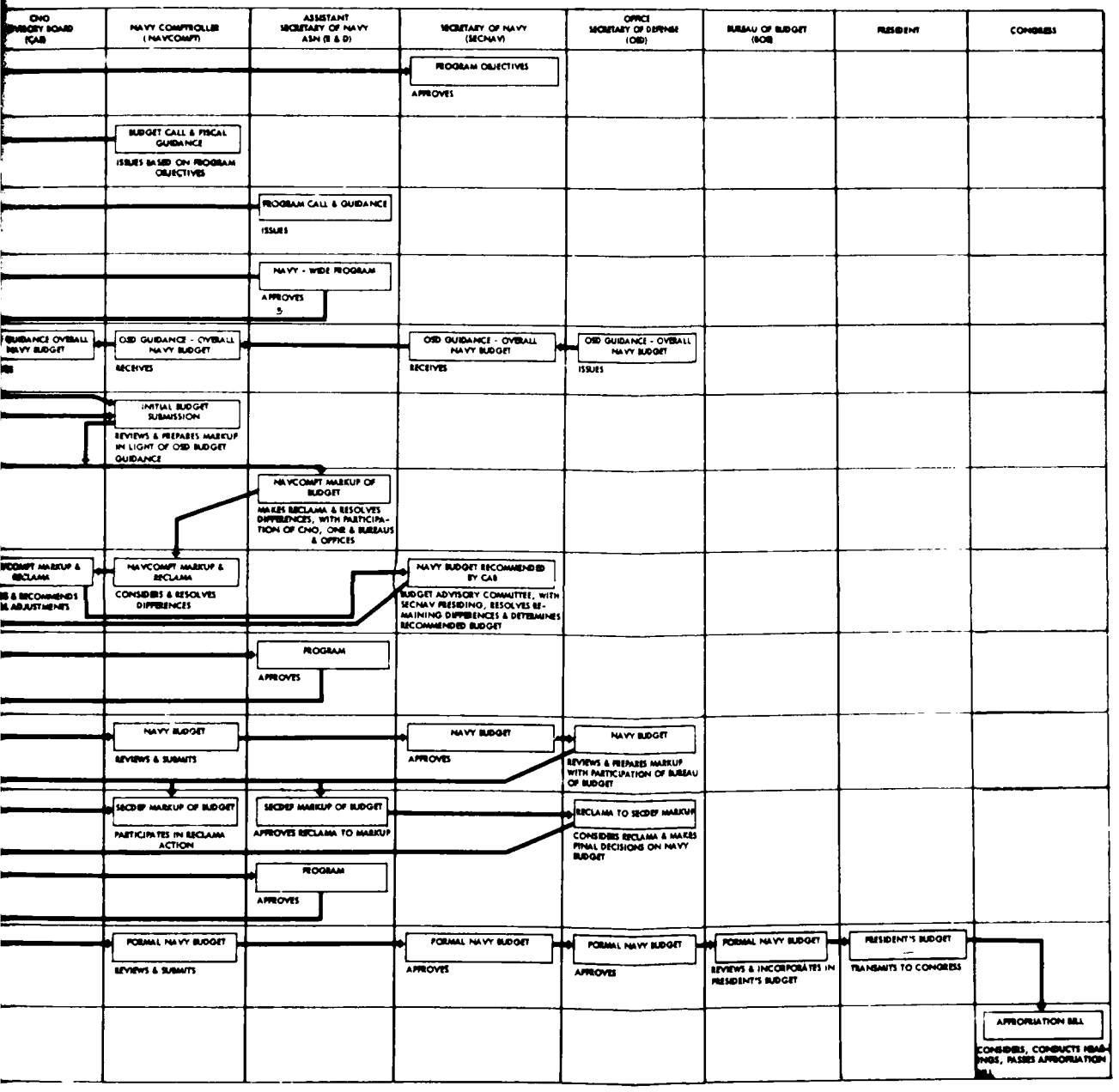
c/ PERFORMS AS OFFICE ASSIGNED OVERALL RESPONSIBILITY FOR RESEARCH PROGRAMS UNDER ASN(R & D)

d/ PERFORMED BY DCNO/D - DEPUTY CHIEF OF NAVAL OPERATIONS (DEVELOPMENT).

e/ ACCOMPLISHED BY REVIEW OF NAVY RESEARCH & DEVELOPMENT COMMITTEE, WITH ASN (R & D) PRESIDING.

SOURCE: DEPARTMENT OF THE NAVY, *REVIEW OF MANAGEMENT OF THE DEPARTMENT OF THE NAVY, RESEARCH AND DEVELO*

EXHIBIT IV-4
Annual Program and Budget Formulation for RDT&E, Navy Appropriation FY62



D DEVELOPMENT MANAGEMENT STUDY, VOL. II, STUDY 3, (DILLON BOARD).

EXHIBIT IV-5
Evolution of RDT&E, Navy Appropriation Definition
($ in thousands)

Approp. Year	Item	Source, Use of Appropriation	DOD Budget Request	Congress Final Action	RDT&E, N Appropriation[a]
1955	RA, Navy Appropriation 1 Year Only	Aircraft & Facilities, Civil Engineering, Ordnance & Facilities, Service-Wide Supply & Finance, Ships & Facilities, Naval Personnel, General Expenses, Marine Corps, Texas & Facilities, Medical Care		+431,000	441,000[b]
1956	ONR, Departmental, Training Equipment Funds, Navy-Wide Patents Transferred to OM,MN-Type Approp.	Service Wide Operations, Navy	+ 7,300		474,000[b]
1957	RAD, Navy Appropriation				830,000
1960	RDT&E, Navy Appropriation Established. Transfers First Increment of I&E Items.	Procurement Appropriations Aircraft & Related Procurement, Navy Procurement of Ord & Ammun., Navy Shipbuilding & Conversion, Navy Procurement, Marine Corps subtotal Oper. & Maint. Appropriations Aircraft Facilities, Navy Ordnance Facilities, Navy Ships Facilities, Navy Marine Corps Facilities Civil Engineering, Navy Total Total	+ 80,000 + 82,737 + 41,500 + 5,000 +154,237 + 5,963 + 1,111 + 21,393 + 800 + 497 + 30,068 +184,305		1,015,000
1961	Transfers: Second Increment of I&E Items	Aircraft & Related Procurement, Navy Procurement of Ord & Ammun., Navy Procurement, Marine Corps Total	+112,000 +104,000 + 5,000 +221,000		1,981,000
1962	BuMed Facility Support International R&D Operation, PMR Kwajalein Site	Operation & Maintenance, Navy Military Assistance RDT&E, Navy	+ 1,000 + 400 + 29,000		1,988,000
1965	Transfers: Long Range Training, RDT&E Flight Hours, Personnel Support Facilities	Operation & Maintenance, Navy	+ 30,000		1,574,000
1969	Transfers: ONR HQ, Branch Offices, Patent Office, Ship Support Flight Hours; Aircraft Support	Operation & Maintenance, Navy	+ 41,000		2,147,000
1970	Transfers: Fleet Support Program SACLANT ASW Research Center	Operation & Maintenance, Navy Military Assistance	+ 57,400 + 400		2,246,000
1971	Transfer S3A Aircraft	Procurement: A/C & Missiles, Navy		+58,000	2,178,000
1973	Transfers: Advanced Ship Design PHM Hydrofoil Ship Naval Training Equip. Ctr., Orlando Naval Arctic Res. Lab, Point Barrow	Shipbuilding & Conversion, Navy Shipbuilding & Conversion, Navy Operation & Maintenance, Navy Air Force	+ 7,500 + 4,500	+10,000 +30,100	2,342,000[c]
1974	Transfers: Atlantic Undersea Evaluation Center RDT&E Ship & A/C Support (Aerial Targets) Anti-Ship Weapons (HARPOON) MK-48 Torpedo Training Devices Prototype Devel. Close In Weapon Support (PHALANX) CAPTOR	Operation & Maintenance, Navy Weapons Procurement, Navy Weapons Procurement, Navy Weapons Procurement, Navy Other Procurement, Navy Weapons Procurement, Navy Weapons Procurement, Navy	+ 10,000	+ 3,400 +14,100 + 5,300 + 2,800 +23,200 + 6,700	2,704,000[c]

Source: ONR, Code 521, March 1974.

Notes: a. All NOA figures (1955-1971) from Enclosure (1) of Memo to OP-098 from OP-028T No. 9-73, 2-21-73.

b. RAD only excluding T&E.

c. Figures supplied by OP-098C.

Notes to Chapter 13

1. Personal Interview.
2. U. S., Congress, House of Representatives, Committee on Appropriations, *Department of the Navy Appropriations for 1954, Hearings* 83rd Congress, 1st Session, Part 1, p. 715.
3. Ibid., p. 143.
4. Ibid., pp. 702-713.
5. Ibid., p. 1064.
6. SECNAV Instruction 5430.20, Subject: Office of Naval Research, June 24, 1954.
7. Personal Interview.
8. Revised Statutes (31 U.S. Code 200; Section 3679).
9. Personal Interview.
10. U. S., Congress, House of Representatives, Committee on Appropriations, *Department of the Navy Appropriations for 1956, Hearings*, 84th Congress, 1st Session, p. 976.
11. Personal Interview.
12. *Navy Appropriations Hearings, 1956*, p. 1000.
13. Memorandum, OP-098T to OP-098, Subject: The Evolution of the Management of the RDT&E,N Program, No. 10-73, March 12, 1973, Enclosure (1).
14. Navy Comptroller (NAVCOMPT) Notice 7100, Subject: Revised Department of the Navy Appropriation Structure, Request for Comments, June 19, 1958.
15. Letter, Maurice H. Stans, Director of the Bureau of the Budget, to the Secretary of Defense, September 10, 1958.
16. Memorandum, Chief, BuAer to NAVCOMPT Response to NAVCOMPT Notice 7100, October 13, 1958 (in ONR files).
17. Memorandum, Chief BuShips to NAVCOMPT, Response to NAVCOMPT Notice 7100, October 13, 1958 (in ONR files).
18. Memorandum, Chief of Naval Research to NAVCOMPT, Subject: Comments on Proposed Revision of Defense Appropriation Structure, October 16, 1958. (All subsequent Bennett quotes are from this source.)
19. Ibid.
20. Memorandum, Advice of Action, Eugene Livesay Special Assistant, OSD, to members of the Armed Forces Policy Council, Subject: FY 1960 Budget Structure, October 27, 1958.
21. Memorandum, Advice of Action, Eugene Livesay, Special Assistant, OSD, to the Joint Secretaries, Subject: Scope of Research and Development and Procurement and Production Appropriations in FY 1960 Budget, November 3, 1958.

22. P.L. 86-166.

23. Memorandum, to the Service Secretaries, from ASD Comptroller, November 19, 1958.

24. Memorandum, ACNO(R&D) to CNO via VCNO, Subject: Recommended Action Concerning Navy Policy for New Research, Development, Test, and Evaluation (RDT&E) Appropriation, FY60 (Confidential), December 9, 1958.

25. Notes for briefing session, ONR Files, December 4, 1958.

26. Memorandum, from ACNO (R&D) to CNO, op. cit., December 9, 1958, Enclosure (2)

27. Personal Interview.

28. Data Provided by ONR, Code 521, March 1975.

29. U. S., Congress, Senate, Committee on Appropriations, *DOD Appropriations, Hearings*, 83rd Congress, 1st Session, 1954. Part 1, p. 483.

CHAPTER 14

MANAGING THE RDT&E,N APPROPRIATION 1960-1973

After 1960, Navy RDT&E financial management was subject to the same external forces that significantly affected both overall Navy R&D organization (see Chapter 6) and the program planning and justification process (see Chapter 11). The creation of DDR&E and the strong McNamara administration intensified the trend in OSD toward centralization of staff authority over the details of defense RDT&E funding that had begun at the inception of the R&D,N appropriation. At the same time, the steadily increasing complexity and cost of defense RDT&E, which by definition was often the first step toward even greater commitments downstream, raised the Navy program (along with the rest of defense R&D), to a new level of attention in Congress. The appropriations committees responded by placing restrictions on the RDT&E,N appropriation. Taken together, these two trends in the financial management process were considered by many R&D managers to have seriously eroded their authority and management flexibility.

RDT&E,N APPROPRIATION MANAGEMENT RESPONSIBILITY AND AUTHORITY

The designation of an ASN(R&D) to interface with the new DDR&E, proved a significant milestone in the evolution of the RDT&E,N appropriation and its management within the Department of the Navy. As indicated in Chapter 4, the ASN(R&D) was assigned overall responsibility for the RDT&E,N appropriation, a unique assignment within the Department of Defense. Major reasons for the assignment were to give the ASN(R&D) maximum effectiveness in dealing with the DDR&E (who had authority over the Defense Department's total RDT&E budget) and to couple his overall Navy R&D program responsibility with control over available funds. Nevertheless, it could not entirely insulate the Navy R&D community from the two incontrovertible trends of the sixties, specified above.

The Role of ASN(R&D)

The first incumbent ASN(R&D), Dr. James Wakelin, considered his management control of the RDT&E,N appropriation critical to the conduct of his office and later observed that it had indeed served two major functions; one external and one internal. On one hand, it assured others that the ASN(R&D) could deliver on joint efforts and could

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effectively "go to bat" for Navy programs. In addition, the power to withhold funding from the RDT&E,N appropriation gave the ASN(R&D) an effective tool against imposition of unwanted programs from above. Within the Navy Department, the power of the purse was a major factor in keeping the R&D community intact and protecting R&D from being preempted by needs for current problems.[1]

In his role as RDT&E,N appropriation manager, the ASN(R&D) was the major protagonist in the formulation and review of the budget, the development of the program, and in its presentation and justification to the Navy Secretary, OSD, and Congress. Similarly, in the budget execution phase, the allocations flowed through the ASN(R&D) to the various Navy claimants. The significance of the assignment was symbolized in Dr. Wakelin's comment that he "lived with the budget every day."[2]

Managing the appropriation "by exception," the ASN(R&D) made most decisions after going over the budget line item by line item, weighing money availability against technological validity, and constantly evaluating the program's progress, e.g., new starts, unanticipated demands, reprogramming requirements, overruns. Means for carrying out his assignments included authority to approve documentation such as Requests for Authority to Negotiate (RANs) and Determination and Findings (D&Fs) (see Chapter 15). Day-to-day administration, recordkeeping, and budget preparation was staffed out for the ASN(R&D) in the Office of the ONR Comptroller in a natural progression from its previous role vis-a-vis the R&D,N appropriation.

The Role of ONR (Comptroller)

After creation of the ASN(R&D) and his assignment of overall responsibility for the RDT&E,N appropriation, authority over ONR was reassigned from ASN(Air) to ASN(R&D). The Chief of Naval Research (CNR), who was named principal adviser to ASN(R&D) on research matters, also provided supporting staff services to ASN(R&D) for coordination and consolidation of budgeting, accounting, and related reporting operations for RDT&E,N through the ONR Comptroller office. This assignment actually clarified and continued "in fact" the previous role of ONR Comptroller in performing financial management functions for the R&D,N appropriation.*

Assignment to ONR of the staff functions for administering the RDT&E,N appropriation was made by Secretary of the Navy Gates, in spite of the Franke Board recommendation that this function be placed in the Office of the Comptroller of the Navy.

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* During the period of transition between the establishment of the "R&D,N" appropriation in 1955 and the designation of the ASN(R&D), financial responsibilities had continued to reside with the bureaus, and ONR had acted as the office responsible for coordination, preparation, and reporting of the appropriation to ASN(Air).

Gates' rationale reinforced the initial thinking about the assignment of the appropriation to the ASN(R&D). First, he noted that since ASN(R&D) had overall cognizance of the appropriation, he should have direct control of the people performing the staff functions for him. Second, a conflict of interest could arise between the Navy Comptroller's review mission for Navy-wide R&D requirements and his performance of detailed planning and defense of R&D budgets. Finally, placing the fiscal unit in the Secretariat would remove it from the daily flow of R&D events and information and would negate the existing, excellent working relationship between the Development Coordination Group and the ONR Comptroller Office.[3]

In carrying out his functions as responsible officer for the RDT&E,N appropriation, the ONR Comptroller prescribed budget policies and procedures for the RDT&E program. He also provided guidance for and coordinated preparation of the budget estimates [after review and approval of ASN(R&D)] for submission to the Secretary of the Navy, OSD, Bureau of the Budget, and Congress. In 1962, the ONR Comptroller was assigned collateral duty as Special Assistant to the ASN(R&D) for Financial Management. In this capacity, he served as principal advisor on fiscal matters relating to the RDT&E,N appropriation, providing technical guidance and direction in financial matters in support of planning and programming responsibilities of the ASN(R&D) and his principal advisors.[4]

In 1969, ONR was delegated the additional responsibility for allocation of RDT&E,N funds to the bureaus and commands participating in execution of the appropriation. Thus, the Comptroller of the Navy passed the RDT&E,N allocation (as apportioned and approved by the Office of Management and Budget (OMB)* and OSD, in its entirety, and with full responsibility for administrative control of authorized funds) to the ASN(R&D). The ASN(R&D), in turn, passed along the responsibility for financial administrative control to the ONR Comptroller. On the basis of guidance to ONR by the several advisors to ASN(R&D) in their areas of responsibility, the ONR Comptroller then made the allocations of the available funds to the administering offices.[5]

Through these assignments, the ONR Comptroller became a key member of the RDT&E management team, and the scope of his/her job was broadened, not only to serve as a central bank for financial information, but also to oversee the legal financial controls imposed by DDR&E.

At least one top-level R&D official later felt that the effect of placing fiscal coordination functions in ONR was to create a conflict of interest since CNR acted both as advisor and judge of the overall program and also as budget defender of his own (research) segment during budget reviews. In addition, since ONR reported directly to ASN(R&D), "decisions were made by the staff of ASN(R&D) which should have been made elsewhere."[6] Others maintained, however, that the ONR Comptroller acted primarily as a filter for funds and for the most part did not influence program decisions.

* The Bureau of the Budget was reconstituted as the Office of Management and Budget (OMB) in President Nixon's executive reorganization of 1970.

The Role of DCNO (Development)

Just as the CNR was designated chief advisor to the ASN(R&D) on the Navy-wide research program, the DCNO(Dev) was double-hatted as coordinator and principal advisor to the ASN(R&D) for Advanced Development, Engineering Development, and Operational Systems Development (Categories 6.3, 6.4, and 6.6). He was also RDT&E,N appropriation sponsor in OPNAV. In that capacity, he prepared RDT&E program guidance, reviewed program content and justifications consolidated by ONR, and coordinated the presentation of the RDT&E,N program before DDR&E, ASD(Comp), and the Bureau of the Budget. He also participated in "reclama" actions resulting from the budget markups and was one of the principal witnesses justifying the RDT&E program before Congress.

There was some dispute over the impact of the DCNO(Dev) designation as appropriation sponsor. On the one hand, it resulted in his becoming involved in the allocation of funds among the bureaus, which some R&D managers found disruptive and which highlighted the longstanding tensions inherent in the bilinear organization. In addition, some felt that the arrangement by which ONR was responsible for appropriation management and DCNO(Dev) for appropriation sponsorship, was unworkable and fragmented. On the other hand, the DCNO(Dev) incumbents were described as extremely skilled at presenting the R&D program and fighting R&D budget battles in the OPNAV arena. This was especially significant in an environment where the biggest problem with the R&D budget was often described as funding and maintenance of large programs and "sacred cows" to the detriment of funding availability and flexibility for "active projects."[7]

The Issue of RDT&E,N Appropriation Management 1966-1973

The issues surrounding the assignments of RDT&E,N appropriation responsibility and sponsorship were complicated and intensified in the late sixties. Following the 1966 reorganization of the Navy Department into a unilinear system, the Chief of Naval Operations was given control over the Navy's whole production complex. To provide financial control and support of his functions, the CNO established a new OPNAV budget office (CNOBO) which became OP-92 in 1971.

On July 1, 1972, the OP-92 Financial Management Divison under CNO was designated "responsible office" for all major Navy appropriations except RDT&E,N. This created an anomaly that revived the question of whether the ASN(R&D) should retain management responsibility for the RDT&E,N appropriation or whether alternatively, it should be reassigned to the CNO for the sake of consistency.

In October 1972, Under Secretary of the Navy Frank Sanders commissioned a study on financial management to consider these alternatives, among other matters. It noted that Alternative One, maintaining the status quo, would:

- Continue ASN(R&D)'s responsibility for management of the appropriation which had been considered by ASN(R&D) to be essential to carry out his responsibilities for matters related to R&D and to provide an effective interface with DDR&E.

- Continue the present Department of Navy R&D organizations which provided a system of vertical "checks and balances," with ASN(R&D) responsible for management of the overall RDT&E,N program and funding, and CNO and CMC responsible for determining requirements and directing program execution.

- Preserve the present RDT&E,N responsible office organization which had been in operation for 13 years during which time a certain degree of professionalism and continuity had developed in the responsible office budget, accounting, and related ADP organizations.

On the other hand, Alternative Two, reassignment to CNO of the RDT&E,N appropriation, would:

- Permit the CNO to make financial management decisions on the RDT&E,N appropriation as it interfaced with the other appropriations for which he was the "responsible office."

- Provide the CNO with capability to monitor the financial status of programs within a central OPNAV organization, and to insert the OPNAV Fiscal Director into the decision process at any point in time.

- Establish consistency between RDT&E,N operating comptrollership functions and those proposed for other Navy appropriations.

In its final assessment of the pros and cons of the two alternatives, the Study Group made the following statements:

> . . . In the short-term, Alternative One is considered to be more advantageous to the DON because of the unique institutional (functional) aspects of R&D management and the historical management expertise in the ASN(R&D) position. This has provided positive benefits to the Navy in terms of R&D program support from Congress, and DDR&E, and in terms of technical management of the Navy's R&D program. However, Alternative Two, subject to further study, should be considered as a long-term alternative as it is consistent with the underlying concept of management of the DON embodied in the 1966 organizational change.

Should Alternative Two be tentatively selected, the report went on to say, a separate study was recommended to provide "positive detailed assurance that Navy R&D management would not be thereby diluted."[8] As of the end of the era, the status quo remained.

RDT&E FINANCIAL BUDGETING UNDER PPBS 1963-1973

Initiation of the PPBS by OSD Comptroller Charles Hitch, effective for the FY63 budget, has been described in Chapter 11 as it related to program planning and justification. The following sections present it in the light of RDT&E financial budget formulation and control of the appropriation.

Existing Budgeting Issues

Among the major deficiencies of the current system which PPBS and the accompanying FYDP were designed to rectify, was the "budget ceiling" approach by which the individual Service budgets were derived according to fiscal guidelines based on Presidential and Bureau of the Budget estimates of what the economy could sustain. Some believed this was tantamount to ignoring the required level of military effectiveness in favor of budgetary constraints. The effect at the department level was that development of the Navy RDT&E budget, for example, tended to depend more on fiscal guidance than on program guidance from higher authorities.

A second problem was the one-year-at-a-time budgeting approach that encouraged emphasis on new starts and correspondingly inhibited consideration of future costs of a program as it advanced toward expensive development and operation phases. Critics variously referred to this as the "foot-in-the-door" or "thin-edge-of-the-wedge" syndrome. Finally, the traditional separation between military planning and budgeting allegedly contributed the following discontinuities, detailed in a 1965 lecture by Hitch:

- These critically important functions were performed by two different groups of people; the planning by the military planners and the budgeting by the civilian secretaries and the comptroller organizations.

- Budget control was exercised by the Secretary of Defense, but planning remained essentially in the Services. . .;

- Whereas the planning horizon extended four or more years into the future, the budget was projected only one year ahead, although. . . the lead time from the start of a weapon development to the equipping of the forces ranged from five to ten years. . .

- Planning was performed in terms of missions, weapon systems, and military units or forces--the "outputs" of the Defense Department; budgeting, on the other hand, was done in terms of such "inputs" or intermediate products as personnel, operation, and maintenance. . . etc.

- Budgeting, however crudely, faced up to fiscal realities. The planning was fiscally unrealistic. . . The total implicit budget costs of the unilateral service plans or of the Joint Strategic Objectives Plan always far exceeded any budget that any Secretary of Defense or administration was willing to request of the Congress.

- Military requirements tended to be stated in absolute terms, without reference to their costs. . . Military requirements are meaningful only in terms of benefits to be gained in relation to their cost. . . [9]

In short, according to Hitch, planning was carried out, on the one hand, without regard to costs; budgeting was accomplished, on the other hand, without reference to implications for military capability.

To resolve these problems, Hitch's PPBS was conceived as a comprehensive management tool to relate resource costs (inputs) to military missions (outputs). It was a framework not only to enhance decisionmaking at the highest level of the Defense Department, but also to provide maximum data and financial information to managers at *all levels.*

Relationships of PPBS to the Congressional Appropriation Structure and Budget Formulation

Following the changes in the fifties, the activity-oriented categories, which reflected the way the Department managed its resources and carried out military planning and budget formulation, was well established and accepted, even by the congressional committees. Nevertheless, they continued to require the existing budget format. The PPBS (described in Chapter 11) had therefore been designed at least partly to bridge the old and new program and budget formats.

The interrelationship between the DOD system and congressional budget structure was founded in "program elements," which aggregated programs and activities across Service lines, on the one hand, and measured costs in terms of total obligation authority within specific account(s) on the other hand. Within DOD, related program elements were also packaged into "major programs," each of which represented a discrete, Department-wide military mission or set of purposes.[10]

Of the nine original major programs, Program VI was designated "Research and Development," including all R&D projects not directly associated with items approved for procurement and deployment. Because of the unique character of R&D, which was managed by separate projects, Program VI contained the largest number of program elements, divided, in turn, into six categories (see Chapter 11).

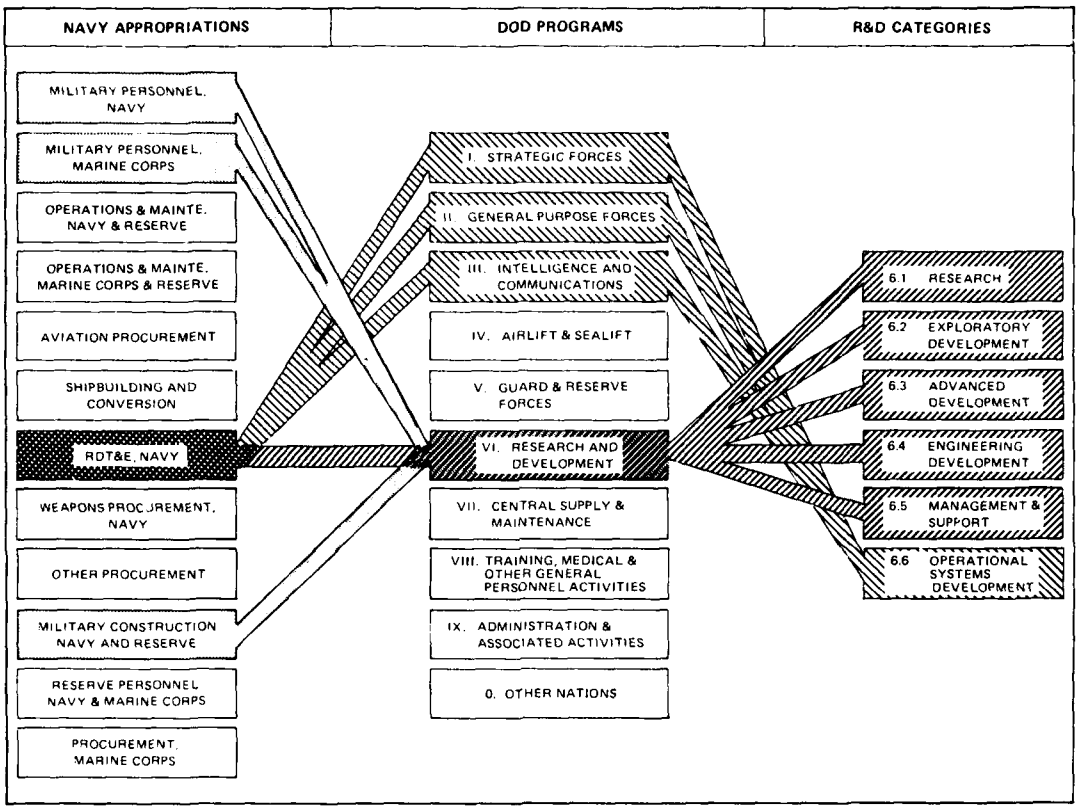
The interrelationship between Program VI, R&D program elements/categories, and the congressional appropriation structure for the Navy is illustrated in Exhibit IV-6. It shows that the RDT&E appropriation and Program VI were synonomous except that (1) costs financed by the Military Personnel, Military Construction, and Family Housing appropriations in support of R&D were also included in Program VI, (2) Operational Systems Development (Category 6.6) was financed by the RDT&E,N appropriation, but included R&D items related to systems and programs already approved for production and deployment, and was reported within the programs of the associated systems, and (3) costs of military personnel assigned to R&D were included only on a statistical basis.[11]

The superimposition of PPBS onto the congressional appropriation structure resulted in a budget triad, depicted in Exhibit IV-7, as it evolved between 1963 and 1973. All data were prepared by program element and aggregated into major programs for DDR&E's technical review. To meet congressional requirements, the same program elements were reaggregated into the eight budget activities of the RDT&E,N appropriation structure to permit congressional review and correlation of R&D with procurement. Finally, RDT&E program elements were described in terms of R&D category and used as the basis for apportioning funds throughout the Navy.

From the OSD point of view, the program element was at once the key to the system and the discrete management entity. "These are the basic building blocks," said Hitch, "as well as the decisionmaking levels of the programming process."[12] As such, they ultimately became an important tool for transferring authority and control upward. OSD/DDR&E reviewed the RDT&E program at the program element level and made decisions to proceed with each phase of a project on the basis of tradeoffs and associated costs of related program elements over a number of years. Similarly, the major programs became the arena in which the Services completed for dollars for program elements that represented alternative or complementary contributions to a military mission; they were the point at which defense needs and costs, ends and means–forces and budgets–were linked.

Following program decisions by the Secretary of Defense, or his staff assistants, all relevant physical and financial data were projected 5 years ahead. This provided the so-called SECDEF-approved "Five Year Defense Plan (FYDP)," the first annual increment of which was the starting point for the subsequent fiscal year budget.

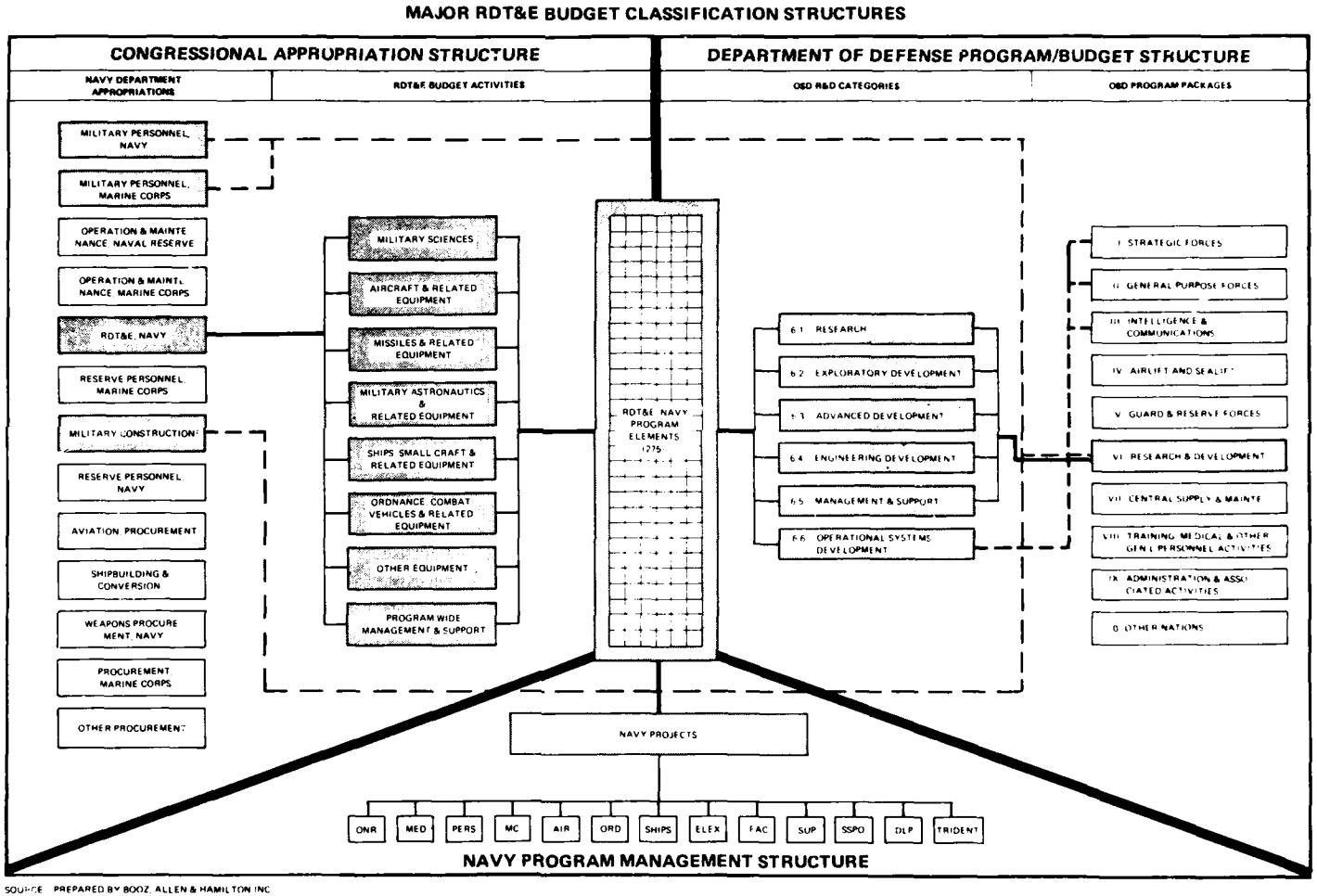
EXHIBIT IV-6
Interrelationship Between Navy Appropriation, DOD Program VI and R&D Categories



SOURCE: PREPARED BY BOOZ, ALLEN & HAMILTON INC.

Thoroughly revising it to conform to the latest OSD decisions, the comptrollers then analyzed it in detail to reflect procurement lists, production schedules, leadtimes, prices, etc., and converted it to the appropriation structure for presentation to Congress. The conversion from program element/FYDP to resource category/appropriation was the mechanical interface between the OSD decisionmaking system and the traditional budget structure.

EXHIBIT IV-7
The Budget Triad



SOURCE: PREPARED BY BOOZ, ALLEN & HAMILTON INC.

Impact of PPBS on Navy Budgeting Process

The new system presented a sizable task in establishing program classification systems, as well as in data handling. The transition was also somewhat facilitated in the Navy because the three-part R&D program structure instituted as early as 1959 (see Chapter 10) closely resembled the new six-part structure. One major problem lay in defining 6.4 and 6.6 so that operational items would not come out of RDT&E money.[13]

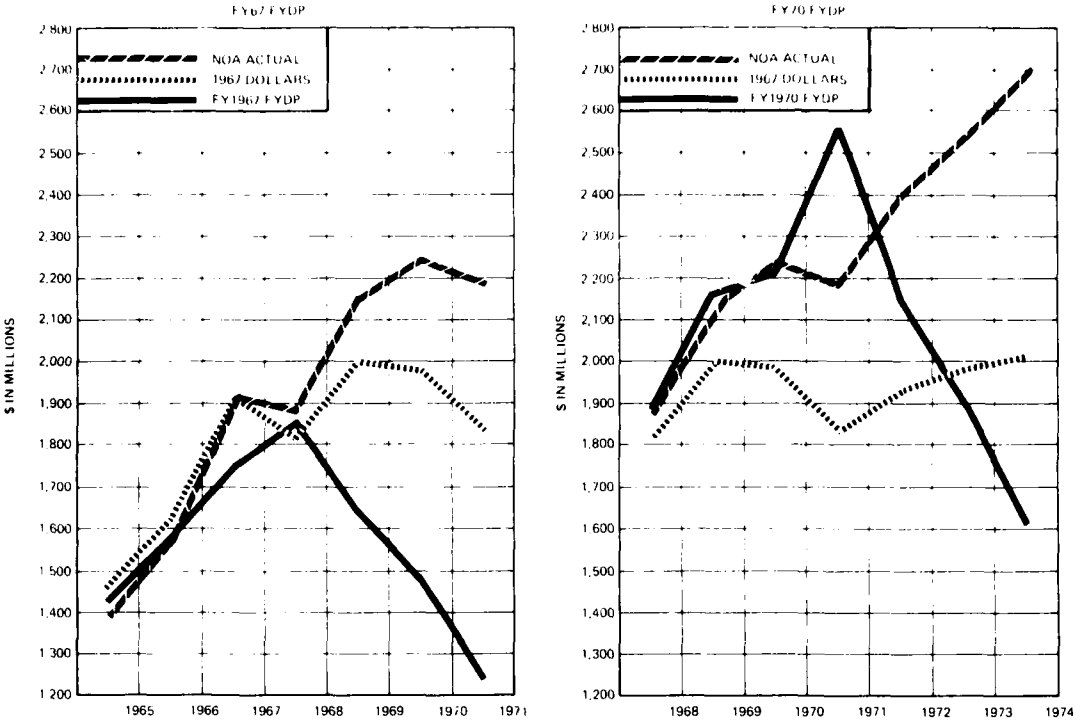
As automated data processing equipment was introduced, many of the technical difficulties were also ameliorated. In fact, a significant side effect of the PPBS was the introduction of modern data processing techniques into the budget process. This actually served the auxiliary purpose of increasing visibility and accessibility of financial resources providing virtually all interested officials, from Congress to the laboratories, with information to facilitate program control at a level of detail previously reserved to the material bureaus.

The initial reaction to PPBS in the Navy bureau's R&D management circles was unfavorable. One top-level official of the time remarked: "PPBS was a challenge, and the Navy fought it instead of responding."[14] This was partly explained by the number and frequency of recent changes (some of which have been described in this chapter) which fostered instability, as well as additional workloads to meet budget submission requirements to higher authorities. This not only inhibited continuity, but also diverted needed technical management personnel from project efforts.

In addition, while many initially recognized some advantages in the FYDP approach to military planning–"It gave the Services the opportunity to exercise intelligent oversight over what they were managing and not to be 'snookered'"[15]–it soon became clear that it did not work quite as planned. One Navy R&D manager observed that, theoretically, no decisions were needed on a given program if it was "good" for 5 years. But in practice, changes were made "by those in power" (in the Services as well as the Office of the Secretary of Defense) just as if there were no plan, and the budgeteers were kept busy updating. "A consequence of the five-year exercise," he concluded, "was that one was always trying to plan for the fifth year ahead with corresponding emphasis on trying to predict what would happen then."[16]

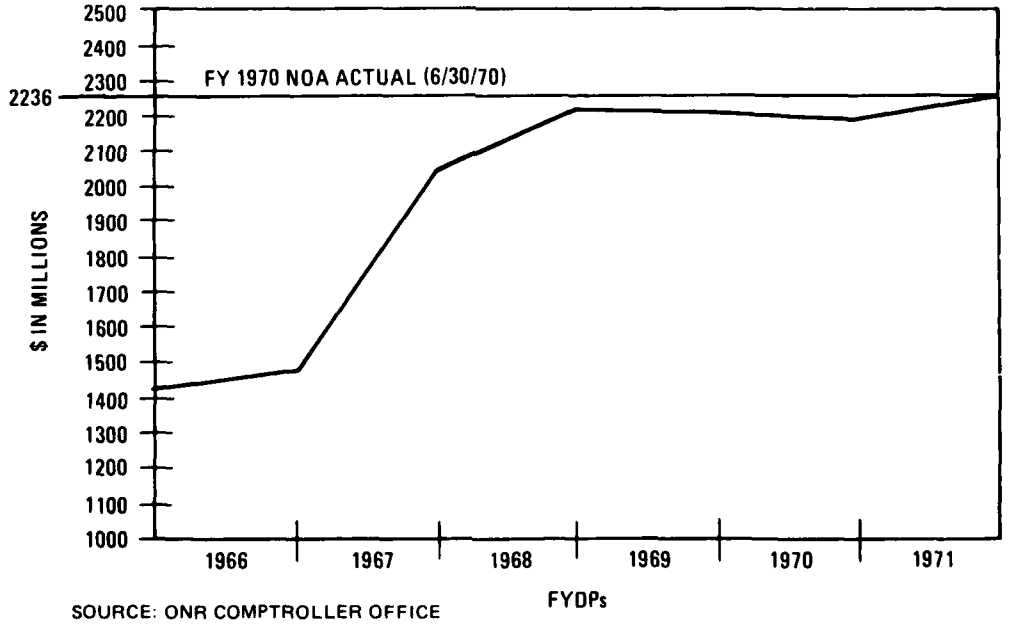
In terms of RDT&E funding, there was a further built-in anomaly illustrated in Exhibit IV-8 by the disparities between two FYDPs (selected at random) and actual appropriations for a given fiscal year. In projecting the R&D program 5 years ahead, there was a natural downturn curve resulting from the combination of programs nearing completion and new starts still unidentified. This produced a gap between financial planning and the level of funding that would be necessary to provide adequate support to those R&D programs that would be starting in the near future. Similarly, as Exhibit IV-9 shows, the budget estimate for each fiscal year changed measurably from FYDP to FYDP.

EXHIBIT IV-8
Relation of 5-Year Defense Plans (FYDP) to
Actual New Obligation Authority, RDT&E,N Appropriation
($ in millions)



SOURCE: ONR COMPTROLLER (FEBRUARY 1975)

EXHIBIT IV-9
Relation of FY70 RDT&E,N Budget Estimates in
1966-1971 FYDPs to Actual New Obligational Authority FY70



SOURCE: ONR COMPTROLLER OFFICE

Several years after initiation of the PPBS, Vice Admiral Bennett, then Director, Navy Program Planning, Office of the Chief of Naval Operations, observed that perhaps its major virtue "as it is now being practiced in the Navy, [was] that it focuses upon, and allows relatively important tradeoffs to be made. . . not just because of the format in which the basic information is presented to the decisionmaker, but also because of the emphasis on incremental gains and costs in the process of choice among competing systems and alternative force levels." At the same time, Bennett noted that "the new budget established categories which obscure other important tradeoffs." The problem lay both in the difficulty of arriving at accurate cost estimates that also reflect the realities and uncertainties of the general economic situation, and in the impossibility of contriving one budgeting format that would "focus attention on all the relevant interdependencies."[17]

By far, the most critical and pervasive reason for discontent among Navy R&D managers was the realization that the PPBS was the tool by which the trend toward centralization of authority and corresponding proliferation of reviews was implemented. If PPBS, like the RDT&E,N appropriation, was not in itself the direct cause of substantive changes in Navy R&D management, it was one of the vehicles through which the changes that were taking place as a result of the creation of the DDR&E were manifested. These effects were symbolized in the Dillon Board R&D management study group's terse observations about the new system:

> Acceptance is. . . not a matter of option. The Secretary of Defense . has directed implementation and the system is in operation. . . The Defense programming and program change procedures are directed at controlling major programs at the highest levels within the Department of Defense.

The R&D management study group under the direction of RADM R. Bennett also noted that reporting requirements by the Department of Defense had substantially increased, and warned that:

> Defense approval of proposed programs will be on a highly selective basis. . . Navy RDT&E programs will have to be extremely well founded.[18]

The key to OSD control over Navy R&D program budgeting, via DDR&E management control and OSD(Comp) financial control, lay in several of the factors highlighted above. It was effected initially through the Program Change Control System (described in detail in Chapter 11); DDR&E's authority (unlike that of other assistant secretaries) to co-sign with ASD(Comp) on all allocations of RDT&E funds; and the assignment of RDT&E reprogramming restrictions (subject to DDR&E approval) at the program

element level. Prior approval of the DDR&E and Secretary of Defense was, therefore, required for program actions that involved initiation of R&D program element or changes in planned obligation for an R&D program element over $10 million in the current or budget fiscal year or $25 million in the total cost.

Most significant perhaps were the restrictions imposed at the new "program element" level for reprogramming of R&D funds. "Reprogramming," i.e., redistribution of appropriated funds between various programs, had always been recognized by Congress as a practice required to permit flexibility and timely response in executing Defense programs, especially those dealing with the highly unpredictable R&D areas. Before 1962, there were no legal restrictions on reprogramming within the total dollar amount of the RDT&E appropriation, except in the case of specific action by Congress. Until 1954, reprogramming was carried out at the discretion of the bureau chief who administered and had authority over specific bureau-oriented appropriations. With the establishment of the R&D,N appropriation and the ASN(R&D), the latter retained legal authority for reprogramming R&D funds; actually, the bureau chiefs continued reprogramming in his name.

Effective July 1, 1962, the RDT&E program element structure was directed by OSD as the basis for administrative control of apportionment, obligation, and reprogramming, subject to all statutory restrictions on appropriated funds.[19] Following congressional action on the appropriations, therefore, the Navy now submitted apportionment requests to BuBud and OSD for approval. The apportionment was supported by a schedule of allocations by program element; program element allocations then became an internal control mechanism by which the comptrollers parcelled out funding and monitored reprogramming actions. Legal restrictions previously at the appropriation level were now imposed on each program element. Furthermore, prior approval by House and Senate Committees on Appropriations were now required for any RDT&E items specifically eliminated or reduced by Congress; effective March 6, 1963, specific approval of the Secretary of Defense, or his Deputy (DDR&E), was required on reprogramming actions of $2 million or more in any RDT&E program element prior to submission to the appropriate congressional committees; and further restrictions specific to RDT&E included reprogramming actions for new programs, new line items, increases in existing programs, and actions to transfer programs from prior fiscal years.[20]

These OSD-imposed changes had the effect of "plunging every program element into the fiscal channel,"[21] and for RDT&E, required even more limited reprogramming authority as several program managers were typically responsible for portions of a single program element. The extent to which this occurred is illustrated in Exhibit IV-10 which shows the FY73 RDT&E,N appropriation broken down by elements and allocations totalling 275 individual portions of money.*

* The simultaneous administration of 3 budget years really meant up to 900 allocations were reported and administered in one calendar year.

EXHIBIT IV-10
Analysis of RDT&E,N Program Elements/Allocations
(Based on FY73 Program as of 30 June 1974)

R&D CATEGOR	6.1	6.2	6.3	6.4	6.5	6.6	TOTAL
NUMBER OF ELEMENTS	2	7	84	48	18	43	202
RESPONSIBLE OFFICE/ ALLOCATIONS							
ONR	2	5	3	–	7	2	19
MED	2	1	3	–	2	–	8
PERS	1	1	2	–	1	–	5
MC	–	–	3	3	3	6	15
AIR	1	5	32	18	5	20	81
ORD	1	2	13	12	4	2	34
SHIPS	1	6	32	14	2	6	61
ELEX	1	4	9	4	1	8	27
FAC	1	1	3	–	1	–	6
SUP	–	1	1	–	1	–	3
SSPO	–	–	–	–	1	2	3
DLP	1	5	–	–	4	1	11
TRIDENT	–	–	–	2	–	–	2
TOTAL ALLOCATIONS	11	31	101	53	32	47	275

SOURCE: ONR COMPTROLLER OFFICE.

The introduction of PPBS, in sum, resulted in decreased program management control and flexibility at the operational level in direct proportion to increased management control at the OSD level. Symptomatic of the changes and the fractionation of reprogramming authority was the difficulty of program managers to focus on broad management and policy decisions, and the tendency of higher level authorities to micromanage the programs. The problems intensified with program complexity. Thus, there were virtually no reprogramming problems for research (where there were only two program elements and most changes could be accomplished within the $2 million threshold), but in the Exploratory Development (6.2) stage and beyond, the $2 million reprogramming limit for line items posed problems. In addition, the authority given OSD to withhold or defer funds exacerbated the situation, creating uncertainties and often precluding adequate time to commit funds before the end of the fiscal year. These deferrals also increased with program costs, technical complexity, and unexpected contingencies.[22]

While defense program planning was eventually adapted to the program structure, the budgeting process retained its resource or functional orientation to satisfy congressional requests. DOD prepared its budget in both terms, but until the 1970's, only the

resource category budget and the accompanying justifications were submitted to Congress. As committee members began to see advantages for their own review functions in the program-type budget, however, it too was submitted during the appropriation hearings.

INTRODUCTION OF THE RESOURCE MANAGEMENT SYSTEMS 1968-1971

In the mid-sixties, the Secretary of the Treasury, the Budget Director, and the Comptroller General, with the strong support of the President, announced their intention to accelerate the thrust toward establishing "business-like" financial systems throughout the Federal government. Accordingly, Secretary McNamara promulgated a directive in August 1966 outlining general policies for Resource Management Systems (RMS) to be introduced throughout DOD.[23]

Primary Objectives of RMS

The basic objectives in RMS application to the Department of Defense were:

- To effect an integrated financial system for planning, programming, budgeting, and accounting
- To identify and cost all resources (i.e., men, materials, services, money), in each appropriation, in each program
- To establish uniformity in classification of financial transactions, accounting, and reporting.

Integration and control were the watchwords; the ultimate goal was to encourage greater cost consciousness and efficiency; the assumed corollary to providing DOD managers with total program information.

Implementation of RMS in DOD was carried out within the context and as an extension of the output oriented approach introduced with PPBS. In fact, RMS was the logical, indeed necessary, next step in developing the PPBS, for it provided a mechanism for eliminating awkward and inaccurate translation of financial information between the program structure and the appropriation (and accounting) structures. By collecting and accounting for actual performance relative to the program structure, RMS bridged the gap between the two and for the first time, made available to managers both planned costs and actual expenses of each R&D project on a current basis.

The new systems for the management of DOD resources were divided into three categories: operations (O&M and Military Personnel appropriations), investments (procurement and construction appropriations), and R&D (RDT&E appropriations). The initial increment of RMS, known as Project PRIME (Priority Management Effort) was concerned only with operating resources; it went into effect 1 July 1967. After more than a year of discussions, reviews, revisions, and recommendations with the defense community, the program dealing with R&D resources was initiated (January 1968) with the issuance of DOD instructions on "Accounting for R&D" and "Research and Development--Program/Budget Costs–Definitions."[24]

Major Features of RMS for Research and Development

Among the most significant features of the research and development RMS as it affected the Navy were:

- Transfer into RDT&E,N of certain R&D costs previously funded from other appropriations, e.g., military personnel engaged in R&D work; the cost of procurement of R&D ships (experimental and prototype); and costs of operation, conversion, and reconversion of ships and aircraft temporarily utilized for R&D. The purpose of the transfers was to identify all actual costs of R&D.

- Institution of either Navy Industrial Fund (NIF) accounting systems or an equivalent working capital fund arrangement at all R&D activities unless specifically excepted. (See Chapter 8.)

- Provision of accrued expense accounting systems to provide all R&D project costs, obligations, and disbursements during discrete time periods

- Implementation of a uniform data element code structure to identify, collect, and aggregate 13 different items of information for every financial transaction.

Implementation of RMS in Navy RDT&E

Implementation of the RMS for Navy R&D was carried out in four stages over a 3-year period. The first phase, initiated in May 1968, established an interim system, including simplified accrual accounting and two NIF cost center conversions. The second phase was implemented on 1 July 1969 with the conversion of the 12 major CNM R&D laboratories to NIF. In response to a specific OSD requirement for a test case, (in exchange for deferral of full introduction of RMS), the third phase began on 1 October 1970 with a pilot project to test RMS at the Naval Air Test Facility (Lakehurst, New

Jersey). Full implementation of RMS was accomplished in the fourth phase, beginning 1 July 1971, utilizing the new RMS handbook, "Financial Management of Resources, RDT&E,N," (NAVSO P-3062) and Uniform General Ledger Account Structure.[25]

From the inception of the drive to introduce RMS, Navy R&D managers expressed serious reservations. Primary among them was the same concern voiced in 1958 (when the R&D appropriation was expanded to include test and evaluation); namely, that the transfer of overhead in direct support of RDT&E, the absorption of indirect costs, the funding of work which had previously been unfunded, and the costs of administering RMS would seriously and artificially inflate the RDT&E,N appropriation, causing adverse congressional reaction. Other persistent concerns were the short period for implementation, the detail required, the data flow between activities and administering offices, and manpower requirements.[26]

Despite these potential problems, ASN(R&D) Dr. Frosch stated at the outset that in the long run, RMS "should more clearly reveal the cost of R&D and may enhance our ability to execute our program. On balance, I believe that we should proceed."[27] In fact, much of what RMS was designed to achieve had already been initiated, in some form or another, in RDT&E where a close relationship between program and appropriation structure, both of which were based on R&D projects, had been established in the formative years of PPBS.[28] In addition, the Navy had successfully used NIF in some R&D activities so that conversion of the remaining major R&D facilities had some precedents.

Nonetheless, in the short term, implementation of RMS caused disruption, increased data flow, and accompanying workload, in addition to the expenditure of large amounts of funds and extensive training of personnel. In the few years between initiation of the full system and 1973, however, the long-term effects had not yet been fully realized.

CONGRESSIONAL INFLUENCE ON THE RDT&E,N APPROPRIATION PROCESS 1960-1973

Congressional interest in and influence on the RDT&E,N appropriation process was manifested qualitatively as well as quantitatively. The most obvious indicators were the level of funding made available for the Navy RDT&E program and the percentage of change imposed by Congress on the RDT&E,N budget after it was presented for appropriations. These are discussed for the entire era in the Summary to Part IV. Congressional influence on R&D management was also increasingly manifested in requirements and restrictions imposed throughout the appropriations process. The establishment of and continuing attempt to "purify" the RDT&E,N appropriation (discussed in Chapter 13), was one such illustration of congressional "influence." Other significant examples evident in the last half of the era are discussed in the following subsections.

Initiation of RDT&E,N Authorization Hearings

Toward the end of the era, Congress asserted its authority materially over several aspects of the appropriation. Expressing increasing concern that substantial funds were committed to future procurements by virtue of their initiation and funding in the R&D process, Congress decided that no RDT&E funds could be appropriated for use after December 31,1963, without specific authorization under Section 412 of the Military Construction Act of 1959. (The previous year, such authorization was made mandatory for RDT&E involving aircraft, missiles, and naval vessels, and prior approval of the House and Senate Armed Services Committees was required for reprogramming involving those items.) Subcommittees on research and development were established in the House and Senate Armed Services Committees to conduct the so-called "Section 412" hearings on RDT&E appropriation authorizations, effective FY64.

The new hearings had the immediate effect of doubling the number of congressional committees to which the budget was presented, and defended, from two to four, with attendant increases in manpower and paperwork required for coordination (internally and with the Committees), justification, and review. Furthermore, individual congressional staff members now had the power to multiply these factors considerably by requesting additional information in any area of interest, which they did with increasing frequency.

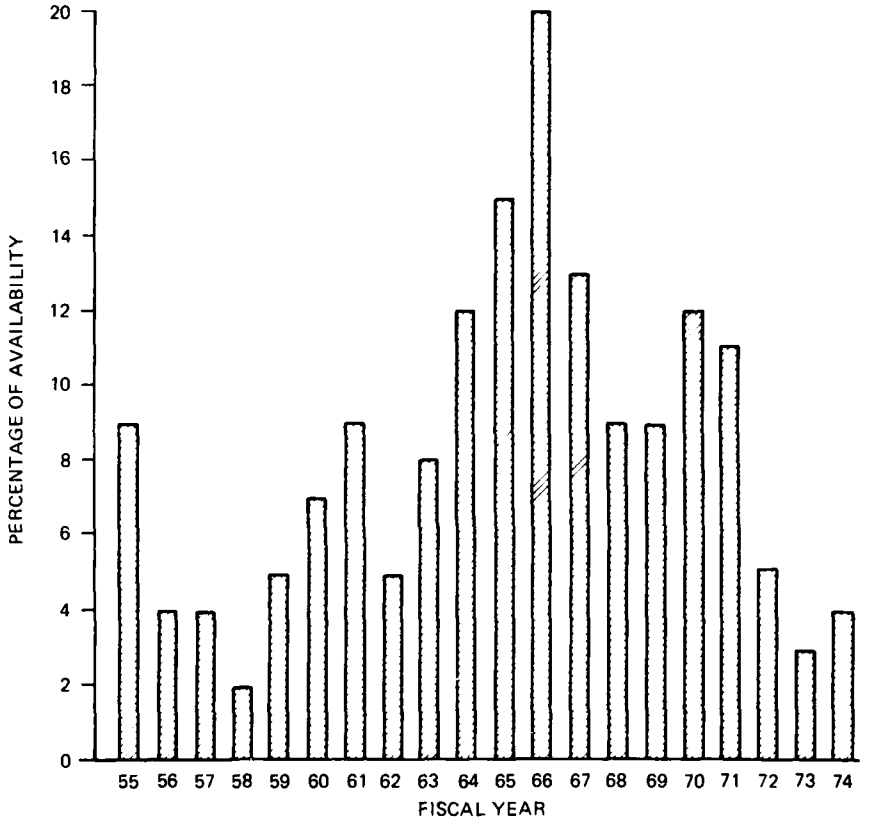
Since other aspects of the DOD budget were undergoing similar changes in direct proportion to increases in funding requested, another practical result was increasingly later passage of appropriations bills. In the last 3 years of the era, for example, the appropriation bill was actually passed more than 6 months after the start of the fiscal year for which the funds were to have been appropriated. While continuing appropriations were passed in the interim, no new starts could be funded, the rate of obligation to be applied was questionable, and a general aura of uncertainty prevailed.[29] In spite of the disadvantages, the authorization committees did not necessarily adversely affect funding levels. In fact, they typically authorized more than was appropriated and, in some instances, acted as strong advocates of the R&D program on the Hill.

Changes to Two-Year Appropriation and Incremental Programming

Congressional concern with levels of funding was matched only by a parallel concern with management of the RDT&E,N appropriation. One cause of the concern was increasing sums of RDT&E money carried over as unobligated balances. Exhibit IV-11 shows the trend in end-year carryovers that culminated in FY66 with a balance of almost 20 percent of the availability remaining at the end of the year. This embarrassing situation was attributable to the combined effects of the project manager's desire to maintain contingency funds and the inhibitions to timely obligation of funds. Both

syndromes were aggravated by late passage of appropriations, growing administrative delays, and withholding of DDR&E approvals as well as the comptroller staff's inability to prevail.[30]

EXHIBIT IV-11
"End-Year" Carryover Balances, RDT&E,N Appropriation, FY55-FY74



SOURCE: ONR, CODE 522 FILE JANUARY 21, 1971 AND INTERVIEW APRIL 1975

To counteract the trend, Congress made two significant changes. In the FY71 Appropriation Act, the RDT&E,N appropriation was changed from continuing funds to 2-year funds. This meant that RDT&E funds were not available for obligation after 2 years. In addition, Congress initiated "incremental programming" for most classes of RDT&E effort. This required that authorization requests in any given fiscal year be limited to only those funds required for work during that fiscal year. Where previously the emphasis had been on the point when the funds were obligated, it was thereby shifted to the point at which work was performed or costs incurred. As a result, annual increases

now paralleled fiscal year obligational authority; programs were budgeted accordingly, and obligations monitored to see that the funds were spent within the fiscal year.[31]

For the R&D program manager, however, this created some uncertainty. For example, he could contract for an experimental aircraft one year, but he had no assurance of obtaining funds for flight tests in subsequent years. With no basis for multiyear contracting he was also unsure of retaining the contractor. In terms of the management problems they sought to overcome, the combined effects of the two changes did succeed in bringing unobligated balances to 3 percent, the lowest point considered "possible" for staying within legal limitations.[32]

Defense Emergency Fund

A further constraint placed on funding for the RDT&E program was a downward trend in appropriations for the Defense Emergency Fund that had been created within the DOD appropriations specifically to provide OSD with a ready source of dollars for use in the event of a "breakthrough" in the R&D program. During the late sixties and early seventies, the fund came under considerable congressional scrutiny when it was alleged that monies were being withheld and then released toward the end of the fiscal year to secure new appropriations the following year. Congress finally reacted by refusing to provide appropriations for the fund.

Restrictions on Reprogramming Requests

Finally, congressional influence was felt in its growing reluctance to approve reprogramming requests. The congressional mood was reflected in a letter from George Mahon, Chairman of the House Committee on Appropriations, to Secretary of Defense Eliot Richardson on March 19,1973, in which he informed the Secretary that "The Committee will not approve any reprogramming requests where the funds requested have been obligated or committed prior to Committee review and approval. . . henceforth the Committee would like to be advised in advance of any new proposals or programs to be initiated by below-threshold reprogrammings. . . in all Defense appropriations."[33]

Shortly after the hearings of that year and final passage of the FY74 appropriation, the Deputy Secretary of Defense wrote: "the attitudes of the Congress have changed in recent years concerning the reprogramming arrangements with the Department of Defense. . . further actions taken by the Congress both in their reports and in the Department of Defense Appropriation Act will restrict the reprogramming process to even a greater degree."[34]

The congressional attitude toward defense reprogramming had evolved from acceptance of the Defense Department's disposition to keep faith with the appropriations committees on the matter of integrity of departmental estimates (circa 1950), to the requirement for prior notification or consent of the committee on certain items (circa 1955), to the extensive prior approval procedures imposed during the sixties, and finally, to where few, if any, reprogramming actions could be assured of congressional approval. The result was that within the RDT&E appropriation, defense reprogramming that had been as high as $994 million in FY61 dropped to $164 million in FY72.[35] Noted one Navy R&D manager of this trend, "It meant the translation of normal uncertainty into 'cost overruns'."

Notes to Chapter 14

1. Personal Interview.
2. Ibid.
3. Memorandum, James Cross, Special Assistant (R&D) to Thomas Gates, Jr., Secretary of the Navy, Subject: Proposed Plans for Implementation of Recommendations of Part 111E of the Report of the Committee on Organization of the Department of the Navy, April 30, 1959; Thomas Gates, Secretary of Navy to James Cross, Implementation of Recommendations of Part 111E of the Report of the Committee on Organization of the Department of the Navy, April 30, 1959.
4. SECNAV Instruction 5430.55, Subject: Designation of Special Assistant (Financial Management) to the ASN(R&D), March 23, 1962.
5. Draft memorandum, from ASN(R&D) to Distribution List, Subject: Operating Budget Allocations for the Research, Development, Test and Evaluation, Navy Appropriation; Administration and Control of, April 11, 1975 (in ONR 520 files).
6. Personal Interview.
7. Personal Interview.
8. Frank Sanders, Under Secretary of the Navy, "Study on Financial Management, Major Recommendation Three, Subject: Financial Management of the Appropriation, Research, Development, Test and Evaluation, Navy" (Washington, D.C.; October 6, 1973) unpublished ms.
9. Charles Hitch, *Decision-Making for Defense* (Los Angeles, 1965), pp. 23-26.
10. Ibid., p. 35.
11. Samuel A. Tucker, ed., *A Modern Design for Defense Decision: A McNamara-Hitch-Enthoven Anthology* (Washington, D.C., 1966), p. 78.
12. DOD Instruction 7220.24, Subject: Accounting for Research and Development, September 18, 1969.
13. Personal Interview.
14. Personal Interview.
15. Personal Interview.
16. Personal Interview.

17. Vice Admiral F.G. Bennett, "Program Budgeting in Navy Management," *Navy Management Review*, XIV, No. 1 (January-February 1969), p. 6.

18. Department of the Navy, *Review of the Management of the Department of the Navy, Research and Development Study*, Vol. II, Study 3 (Washington, D.C., October 19, 1962), NAVEXOS P2426.B3, pp. 129-43.

19. Memorandum, for the ASN(FM) from ASD(Comp), Subject: RDT&E Appropriations - Budget Subcontracting Structure, June 29, 1962 (the restrictions were subject to Section 3679 of the revised statutes as amended by Section 1211, P.L. 759, 81st Congress); and DOD Instruction 7250.10 of 5 March 1963, Subject: Implementation of Reprogramming of Appropriated Funds.

20 DOD Instruction 7250.10, Subject: Implementation of Reprogramming of Appropriated Funds ASD(Comp), March 5, 1963, and NAVCOMPT Instruction 7133.1A, Subject: Procedures and Reporting Requirements Related to the Reprogramming of Appropriated Funds; implementation of, August 7, 1963.

21. Personal Interview.

22. Personal Interview.

23. DOD Directive 7000.1, Subject: Resource Management Systems of the Department of Defense, 22 August 1966.

24. DOD Instructions 7220.5 and 7220.24 of 24 January 1968.

25. OASD(Comp), "Improvements in Budgeting and Accounting for Research and Development, A Compendium of a Regional Symposium." Washington, D.C., May 1971, pp. 71-72.

26. Memorandum for the ASN(FM) from Robert Frosch, ASN(R&D), Subject: Comments on DOD Draft Instruction: Accounting for Research and Development, April 25, 1969; and Memorandum for the ASN(R&D) from CNR, Subject: Implementation of the Research/Management System in the RDT&E,N appropriation, September 22, 1969.

27. Memorandum for the ASN(FM) from ASN(R&D) 25 April 1967, op. cit.

28. OASD(Comp), "Improvements in Budgeting and Accounting for Research and Development", p. 35; Personal Interview.

29. Memorandum for the ASN(R&D) from Vladimir Szarek, Counsel, NAVCOMPT, Subject: Expenditure Costs Under the Continuing Resolution Act, March 24, 1975.

30. Personal Interview.

31. Briefing notes for ONR(Comp), February 15, 1974 (in ONR files).

32. Personal Interview.

33. Letter, to Honorable Eliot Richardson, Secretary of Defense from George Mahon, Chairman, House Committee on Appropriations, March 19, 1973.

34. Memorandum, for the DDR&E, Assistant Secretaries of Defense, Assistants to the SECDEF from the Deputy Secretary of Defense, Subject: Control of Reprogramming Actions, January 23, 1974.

35. U.S., *Congressional Record*, June 3, 1974, S9423.

SUMMARY

PRINCIPAL TRENDS IN R&D FINANCIAL BUDGETING AND APPROPRIATIONS 1946-1973

A retrospective analysis of postwar Navy R&D financial budgeting and appropriations provides major indicators of the growth of Navy R&D. An examiniation of these vital signs and their interrelationships reveals two types of trends. The first relates to management aspects of the process discussed in detail in the preceding chapters. Major milestones in the evolution of the financial budgeting and appropriations process are depicted in Exhibit IV-12 and the underlying trends are summarized in the first three sections below. Additional sections are devoted to a brief summary of the second type—trends in the R&D,N/RDT&E,N appropriations funding levels throughout the era.

THE SHIFT IN FINANCIAL BUDGETING AND APPROPRIATIONS ORIENTATION

A significant postwar characteristic of Navy R&D funding was the long-term shift in financial budgeting focus and control away from the individual bureaus in the forties and fifties toward a centralized Navy-wide RDT&E program in the sixties and seventies. Until 1955, financial management concerns rested primarily with the bureaus. The frame of reference, point of control, indeed the whole character of R&D financial budgeting was defined in terms of the material bureaus which executed the program. R&D was defined only within the context of the bureaus' overall budgets and appropriations. To the degree that responsibility and authority for budget formulation were firmly vested with the bureau chief, broad reprogramming authority within the bureau's blanket appropriations also testified to the extent of his flexibility and control over funding expenditures. Conversely, during those early postwar years, research and development was almost invisible to high-level authorities as a Navy-wide program: only by digging into the details of each bureau's projects and then fitting inconsistent and often ill-defined pieces together could some overall picture be surmised.

The first change in this pattern was the establishment of uniform R&D line items in the bureaus' FY51 appropriations. A more significant departure was the establishment in FY55 of "Research and Development, Navy." This first Navy-wide account was a major turning point in identification and management of R&D financial budgets. With the imposition of the Planning, Programming, and Budgeting System (PPBS) in FY63, emphasis on the DOD program element as the major focus of management had progressed to the extent that the Navy R&D organizations, i.e., the bureaus, had almost dropped out of sight in the financial budgeting and appropriations structures.

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SHIFT OF FINANCIAL BUDGETING, AUTHORITY, AND CONTROL TO OSD

The phenomenon described above was inextricably bound to the drift upward of authority which coincided with the centralization of R&D control in the Office of the Director of Defense Research and Engineering (DDR&E). On a procedural level, the shift was reflected in ever-increasing reviews at higher staff levels and a corresponding reduction of flexibility at Navy operating levels. It can also be gauged by the fact that RDT&E programming and budgeting became the only DOD appropriation to undergo a unique dual-route approval process. It was the only DOD appropriation that was submitted to two independent review and approval routes: the program side (from the Navy up through DDR&E) and the Comptroller side [from ONR (Comptroller)] to the Navy Comptroller up through the OSD (Comptroller).

The close management control and review of financial budgeting by DDR&E was effected through various mechanisms, of which PPBS proved significant. Through implementation of PPBS, both program elements and R&D categories were reviewed and approved across Service lines by OSD, thus providing a powerful mechanism for high-level decisionmaking and control as well as interservice competition for R&D funds. Furthermore, the increasingly detailed compartmentalization afforded a growing and more visible information base upon which to make decisions and control expenditures.

OSD's management control was still further enhanced in the sixties by the power to impose reprogramming limits at the program element level. This seriously reduced the Services' authority and flexibility with respect to the expenditure side of the budgeting and appropriation process. More important were the long-range implications: OSD's ability to break down and control funding availability and expenditures for discrete segments of the R&D program had provided the means to control at the highest level in the organization the entire R&D progress from planning to program execution. It also had some unexpected impacts on the evolving role of Congress, described in the following sections.

INCREASED CONGRESSIONAL REVIEW AND RESTRICTIONS

Many of the changes summarized above–notably, the tendency toward concentration of control in OSD over the Navy's financial budgeting–also tended to preempt some congressional initiative. The legislature was now in the position of having to consider choices that had been thoroughly filtered through the OSD review process. Partly to reestablish their own control and partly as a reaction to the constantly spiralling defense costs, Congress began to impose a series of restrictions on RDT&E appropriations toward the end of the sixties. These were manifested in more and more committee hearings, many of which reflected increased requirements for prior approval and reporting of

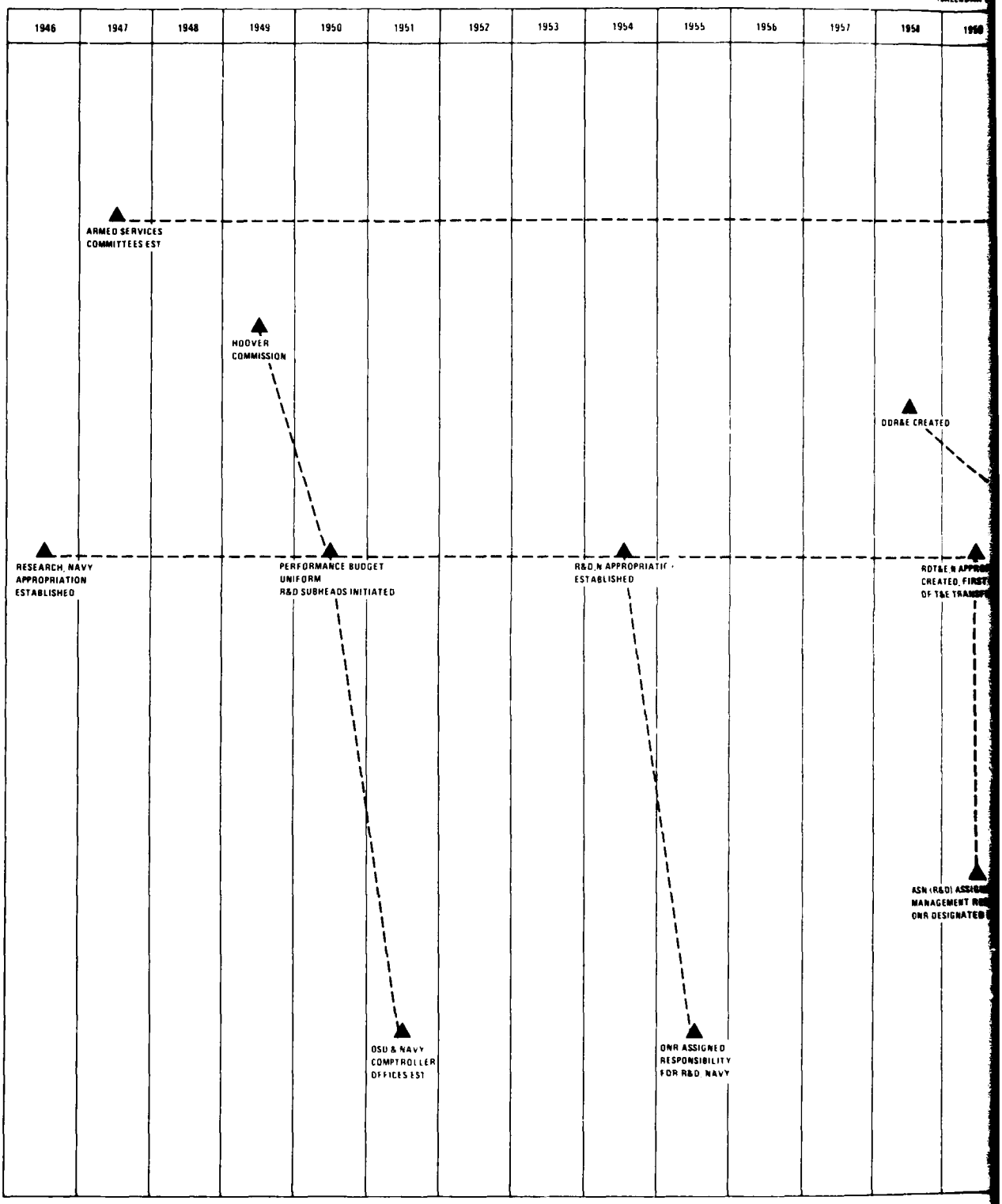
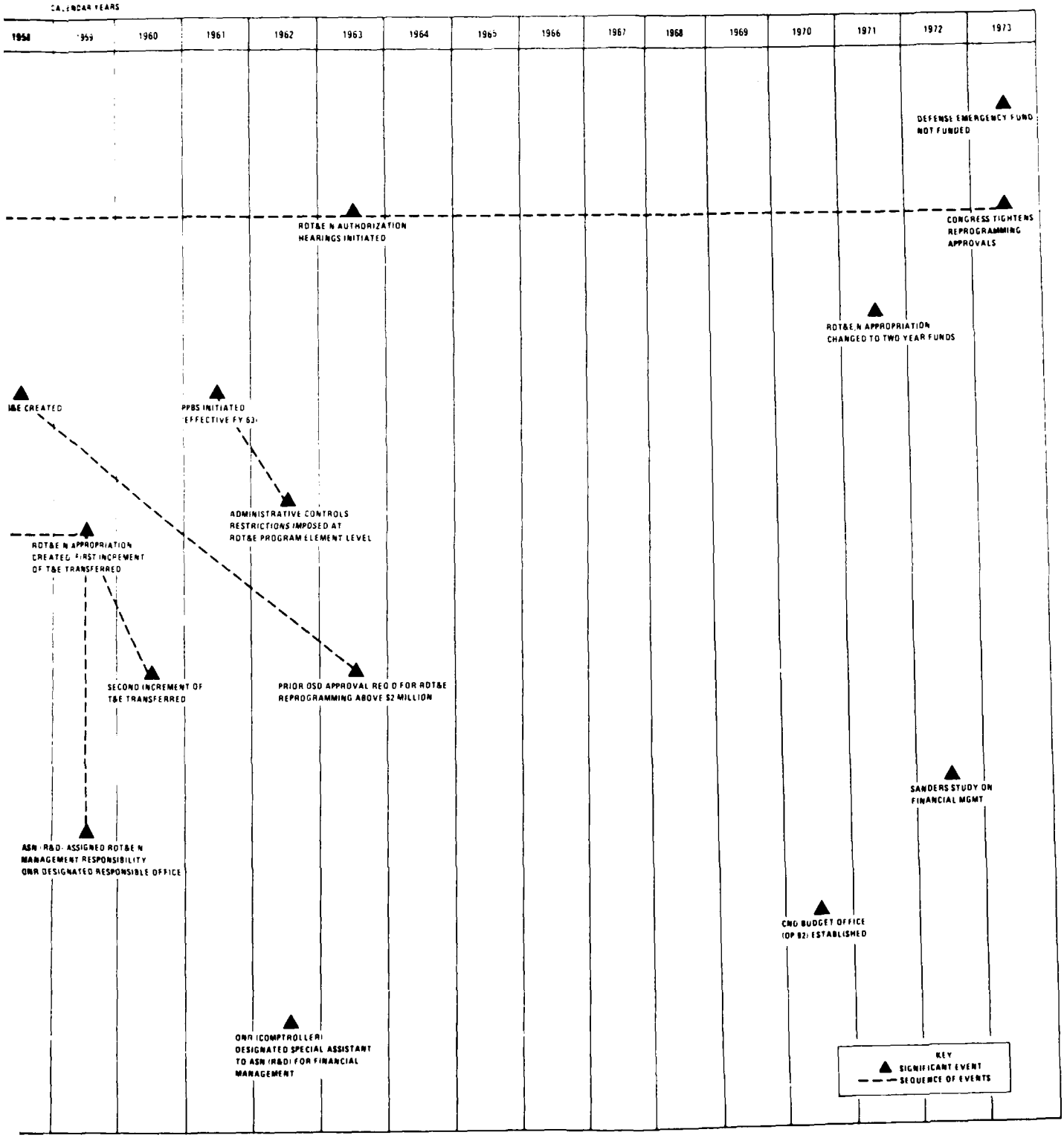
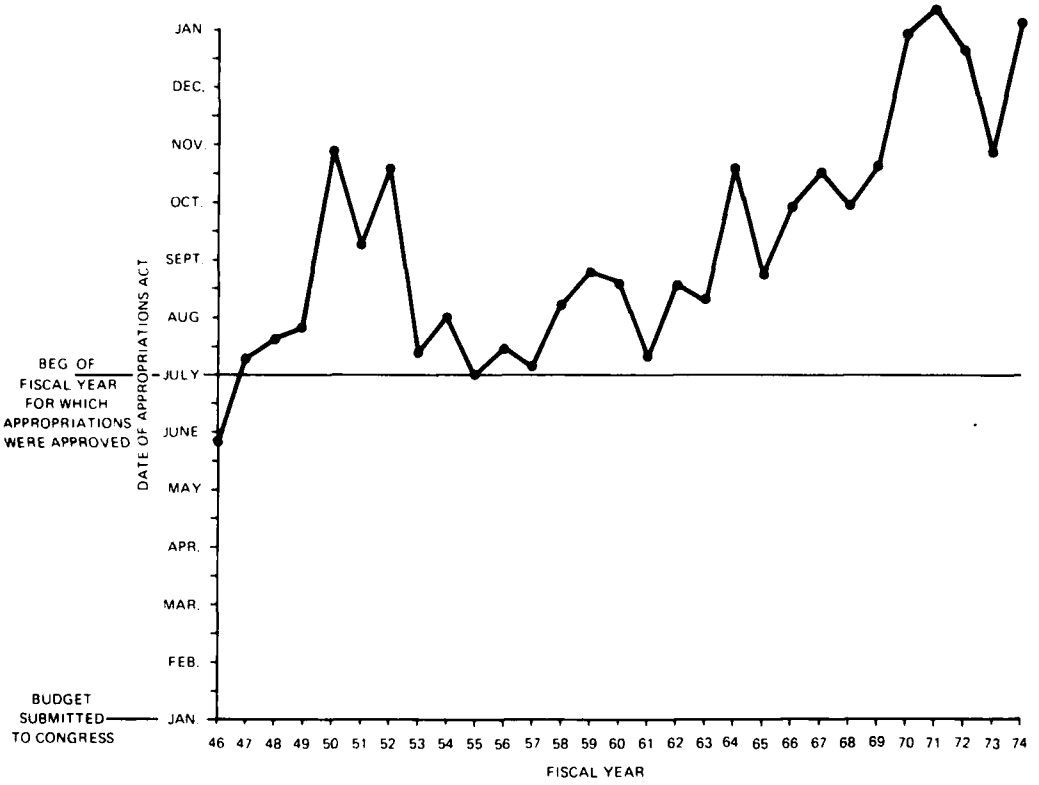

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RESEARCH, NAVY APPROPRIATION ESTABLISHED
PERFORMANCE BUDGET UNIFORM R&D SUBHEADS INITIATED
R&D,N APPROPRIATIO ESTABLISHED
RDT&E,N APPRO CREATED, FIRST OF T&E TRANSF
ASN (R&D) ASSIGN MANAGEMENT RE ONR DESIGNATED
OSD & NAVY COMPTROLLER OFFICES EST
ONR ASSIGNED RESPONSIBILITY FOR R&D, NAVY

Exhibit IV - 12
Significant Milestones for R&D Financial Budgeting and Appropriations 1946 - 1973



reprogramming. The trend culminated in the early seventies with an almost total refusal to grant such requests. By the end of the era, Congress also denied any monies whatever for the Defense Emergency Fund. Finally, the availability of RDT&E funds was restricted to 2 years, accompanied by initiation of incremental request procedures. At least one overt indication of Congress's increasing review and involvement in the RDT&E financial processes was progressively later passage of appropriation bills, as illustrated in Exhibit IV-13.

EXHIBIT IV-13
Dates of Passage of Appropriations,
Department of the Navy FY46-FY74



SOURCE: APPROPRIATIONS ACTS 1946-1974.

Some of these measures provided better management control not only for OSD and Congress but also for the Navy Department. Many R&D managers believed, however, that they imposed excessive restrictions, which eroded their authority, compromised their flexibility and, on balance, ultimately inhibited optimum R&D management.

THE GROWTH OF NAVY R&D/RDT&E FUNDING LEVELS

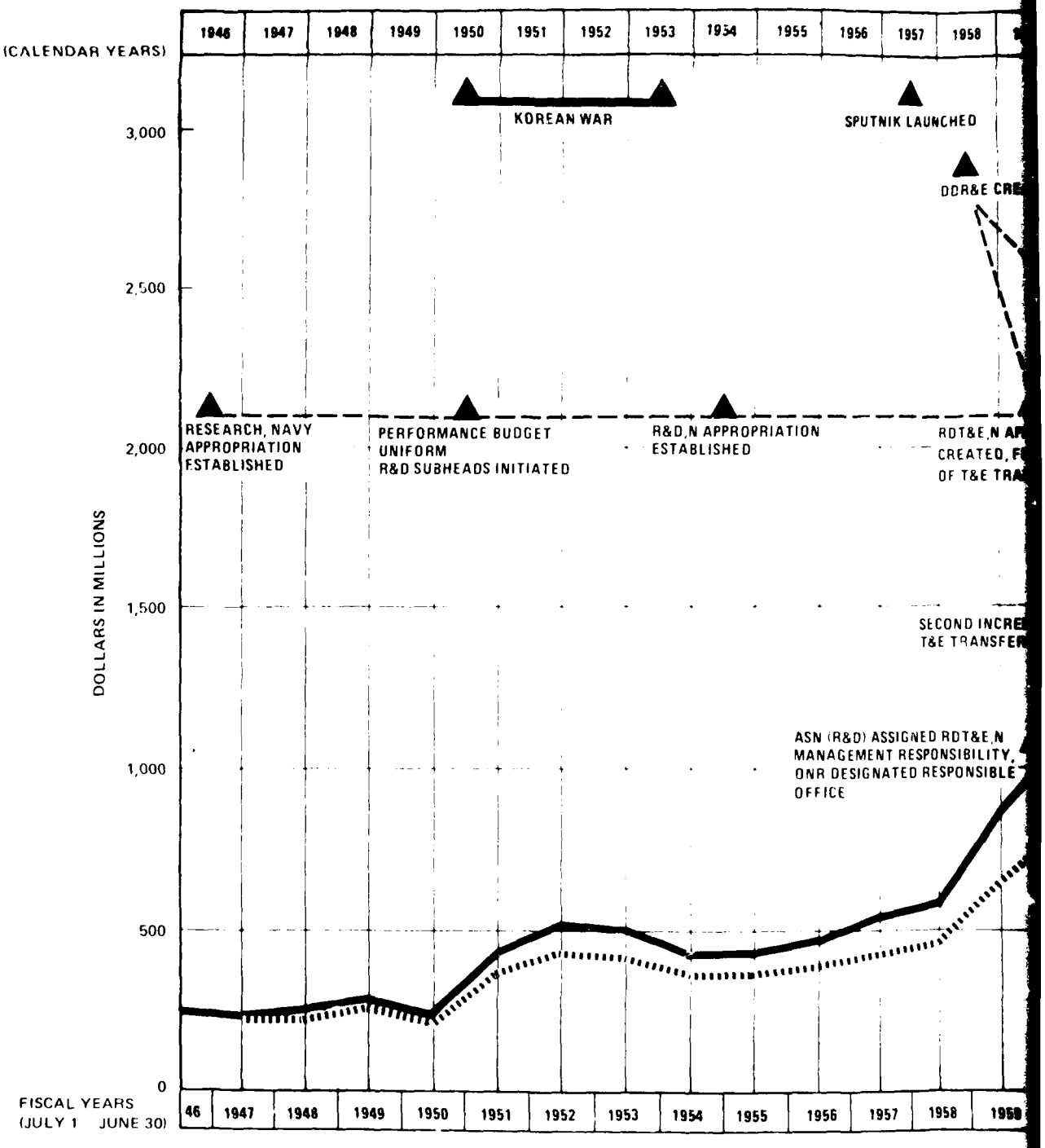
Exhibit IV-14 shows the 27-year trend in R&D,N/RDT&E,N funding levels along with pertinent milestones. The first and most obvious phenomenon in postwar research and development funding levels was the steadily upward trend in New Obligational Authority (NOA) both in absolute dollars and dollars adjusted for inflation. Between FY47 and FY74 budgets, the R&D,N/RDT&E,N appropriation increased by a factor of 12 (by a factor of 6, adjusted to the military price index), and showed an annual rate of growth of 9 percent (approximately 6.4 percent adjusted). Exhibit IV-15, also indicates a growth in R&D,N/RDT/E,N as a percentage of the total Navy budget during the era. Between FY55 and FY59, the year prior to the expansion of R&D,N to include related test and evaluation, the appropriation had increased from 4.3 percent to 7.4 percent of the total Navy budget. The FY74 RDT&E,N appropriation was almost 10 percent of the total or more than twice the FY55 percentage.

In the aggregate, these statistics present a picture of steady growth in R&D funding throughout the era. Underlying these figures, however, were some factors whose impact many argued made the appropriations' growth more apparent than real.

The most significant of these was the frequent redefinition of the appropriation to include items not previously funded with research and development monies. The issue focused on the tendency of such transfers to artificially inflate the base budget, thus prodding Congress to make greater reductions when funding was tight. Furthermore, mandated as across the board cuts, these reductions inevitably represented larger absolute dollar cost for program items other than those which actually caused the budget's bulge. The first step in this trend was the addition to the R&D,N appropriation of funds for test and evaluation. The immediate effect was a jump in the appropriation of 23 percent, compared to what would have been an actual increase of only 1 percent in the level of funding for those items historically included in the R&D,N appropriation.

Throughout the sixties, additional transfers were made to RDT&E,N from other appropriations, culminating the FY69 transfer of new ship concept developments. The R&D community looked upon this last item with particular alarm, because it seemed to set a precedent for including items that would consume a disproportionately large piece of the total RDT&E,N budget.

In analyzing this issue, it should be noted that there is no way to calculate accurately the cumulative effect of the many transfers in and out of the R&D,N/RDT&E,N appropriation. While dollar figures for a specific transfer in a given year were evident, evolutionary changes in the program's makeup as well as shifting of projects, reprogramming, administrative changes, and new reporting requirements virtually prohibited identification of that portion of future budgets allocated to previously transferred items.



SOURCE PREPARED BY BOOZ, ALLEN HAMILTON INC.

EXHIBIT IV-14
R&D,N/RDT&E,N Appropriations, NOA
Funding Levels 1946-1973

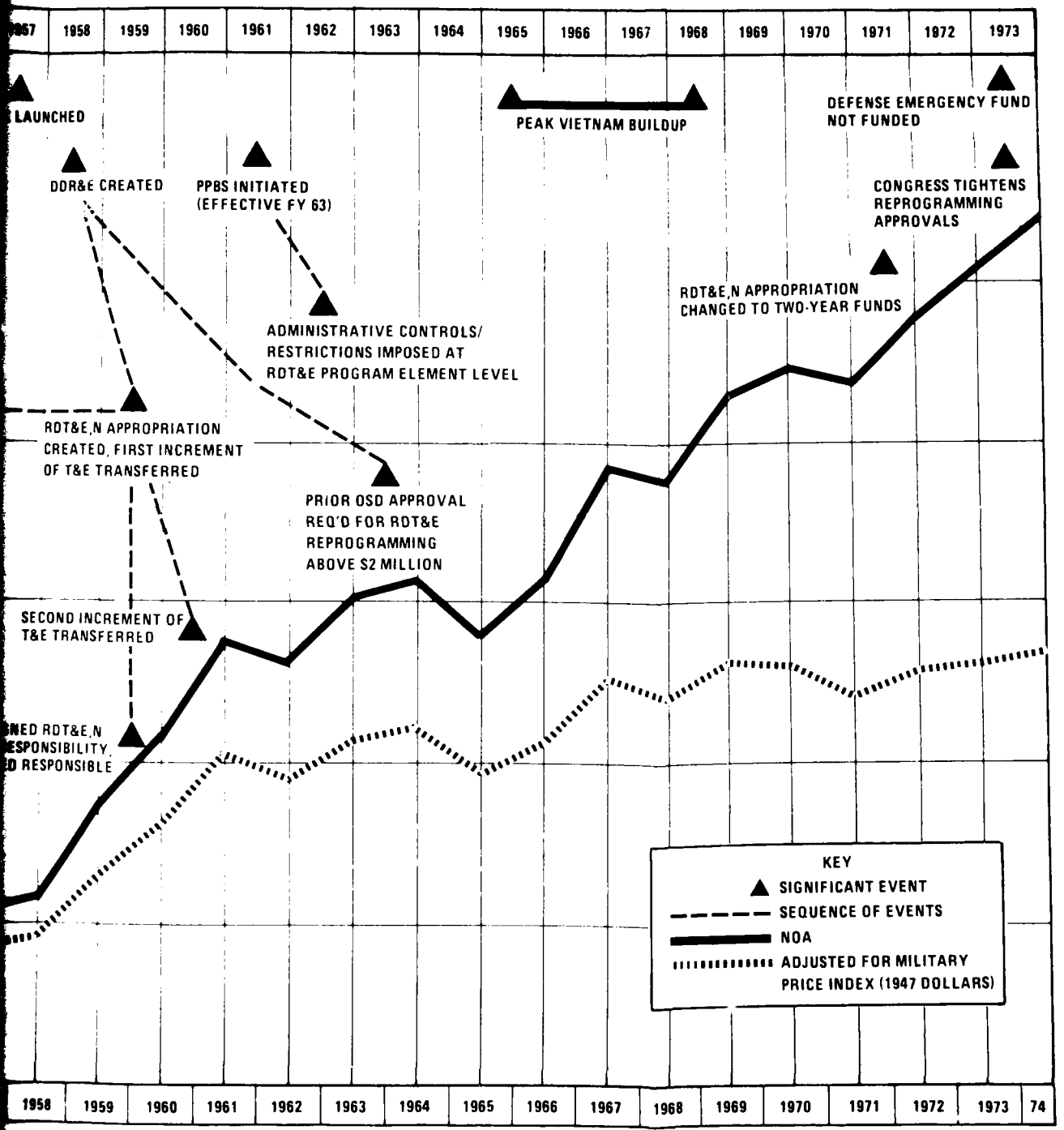
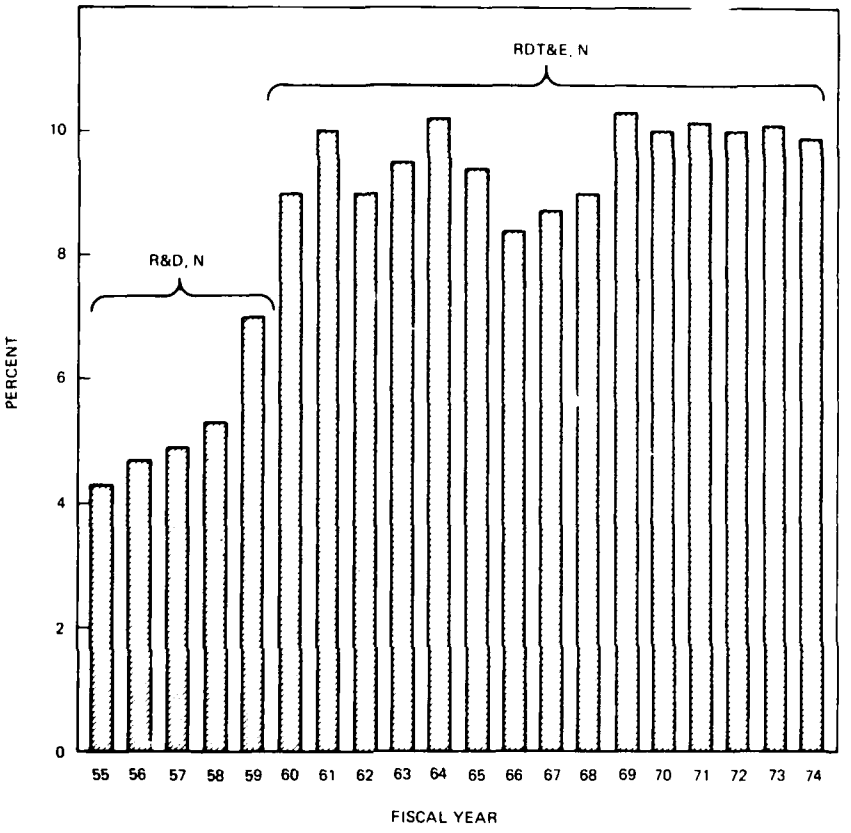


EXHIBIT IV-15
RDT&E,N as Percent of Total Navy Budget
FY55-FY74



SOURCES: ONR CODE 521, MARCH 1958 AND 1975; OASD (COMP) FADs, "COMPARISON OF SERVICE REQUESTS WITH PRESIDENT'S BUDGET, FY56-FY74."

Secondly, as noted above, there had already been a marked increase in the R&D,N appropriation before the first major transfers in FY60. Finally, from a substantive (and undoubtedly congressional) point of view, most of the items transferred into the RDT&E,N appropriation were indeed research and development items, which had previously been funded in other appropriations. For years, R&D managers were effectively getting some of their program money "free."

THE INFLUENCE OF CONGRESS ON NAVY RDT&E,N FUNDING

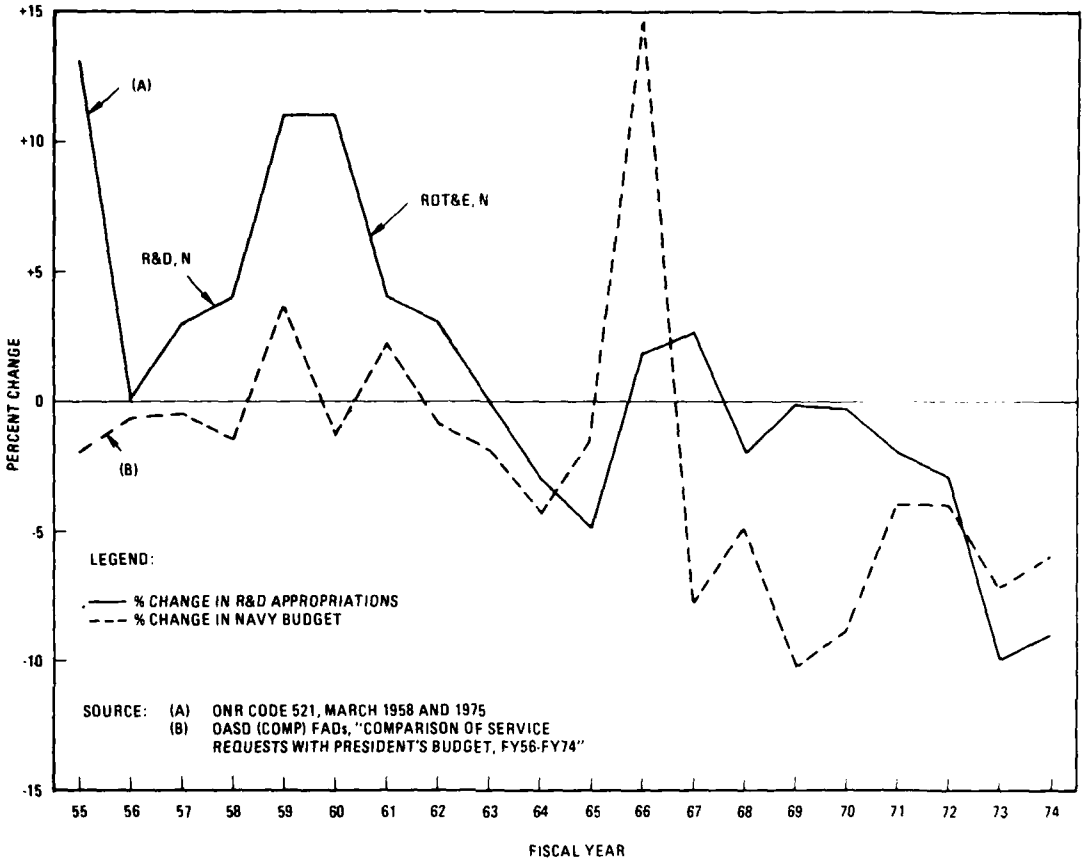
An additional significant characteristic reflected in the 27-year funding trend (Exhibit IV-14) was the influence of shifting congressional attitudes. Even a cursory examination reveals that fluctuations–sudden increases and decreases–in the generally increasing funding for research and development were usually directly related to the general national environment, e.g., the state of the economy, specific events, and/or administration policies. During the Korean War, funds for R&D increased; in the subsequent recession, they declined; following Sputnik, they increased; during McNamara's early sixties cost-reduction campaign, they decreased; and during the Vietnam War buildup, they increased again.

A further measure of congressional attitudes and influence over RDT&E,N funding levels is displayed in Exhibit IV-16. It illustrates the direction and percentage of change Congress imposed on RDT&E,N budget estimates and also compares them to the related changes in the total Navy budget. While the general effect of external events is evident here, too, it is notable that congressional actions on RDT&E funding often ran counter to those on the total Navy budget. For example, in 7 years more funds were appropriated for RDT&E,N than had been requested, while total Navy budget requests were cut. In two of the three years in which both appropriations figures were higher than requests, RDT&E,N gains outpaced those for the total Navy budget. In only three years of the nine years in which they both received cuts were those for RDT&E,N greater than for the overall Navy budget. No less significant is the readily apparent, consistent congressional tendency after FY66 (the peak year of Vietnam buildup) to slash budget requests and appropriate less money than estimated for both RDT&E,N and the Navy as a whole.

INCREASED FUNDING OF THE SYSTEMS' END OF THE RDT&E SPECTRUM

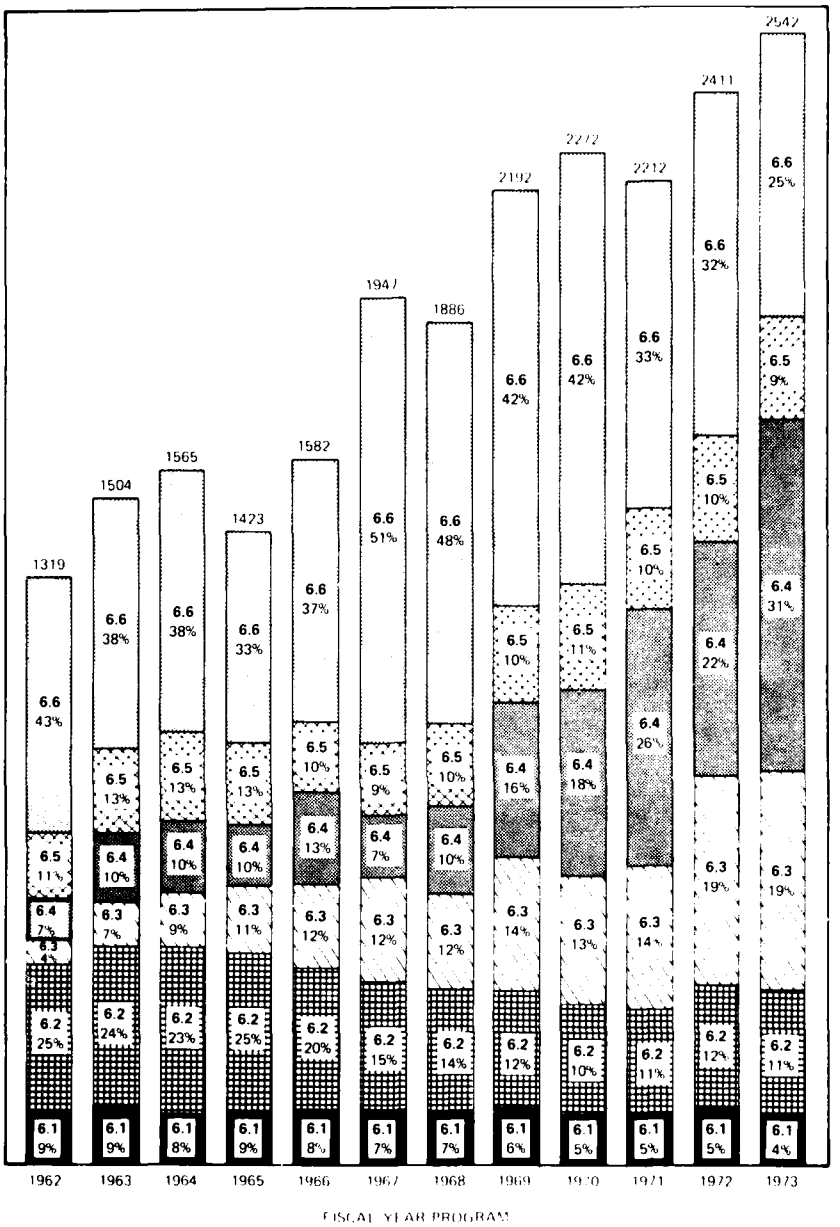
Further analysis of the growth of the RDT&E,N appropriation is provided by a breakdown of RDT&E,N funding by category after FY62, shown in Exhibit IV-17. An examiniation of the percentages of the total RDT&E,N budget shown for each category reveals that within the framework of the overall growth trend, the percentage of funds allocated to the early phases of the program, i.e., Research and Exploratory Development (6.1 and 6.2), experienced a sustained decline: both dropped by more than half over the entire decade. By contrast, the percentage allocated to Category 6.3, Advanced Development, almost quintupled; and the percentage allocated to 6.4, Engineering Development, grew by a factor of 4.5 to almost one-third of total RDT&E,N funds by the end of the era. In the same period, 6.6, Operational Systems Development, reached a peak (FY67) with more than half of the total RDT&E,N funds, after which it declined to where it still consumed one-quarter of the total appropriation.

EXHIBIT IV-16
Percent Congressional Change Imposed on RDT&E,N and Total Navy Budget Estimates FY55-FY74



This same phenomenon is more specifically illustrated by the growth displayed in Exhibit IV-18 of funding for certain high dollar programs and special projects (e.g., Polaris/Poseidon, F-14/F-111). Growth in these large and expensive programs was due partly to national inflationary trends which most seriously affected the complex, Advanced Engineering and Operational Systems Development ends of the RDT&E spectrum. But it was also symptomatic of the proliferation, per se, of this type of program in the Navy; and it contributed significantly to a feeling that resources available to many R&D managers within the SYSCOMS were dwindling, not growing.

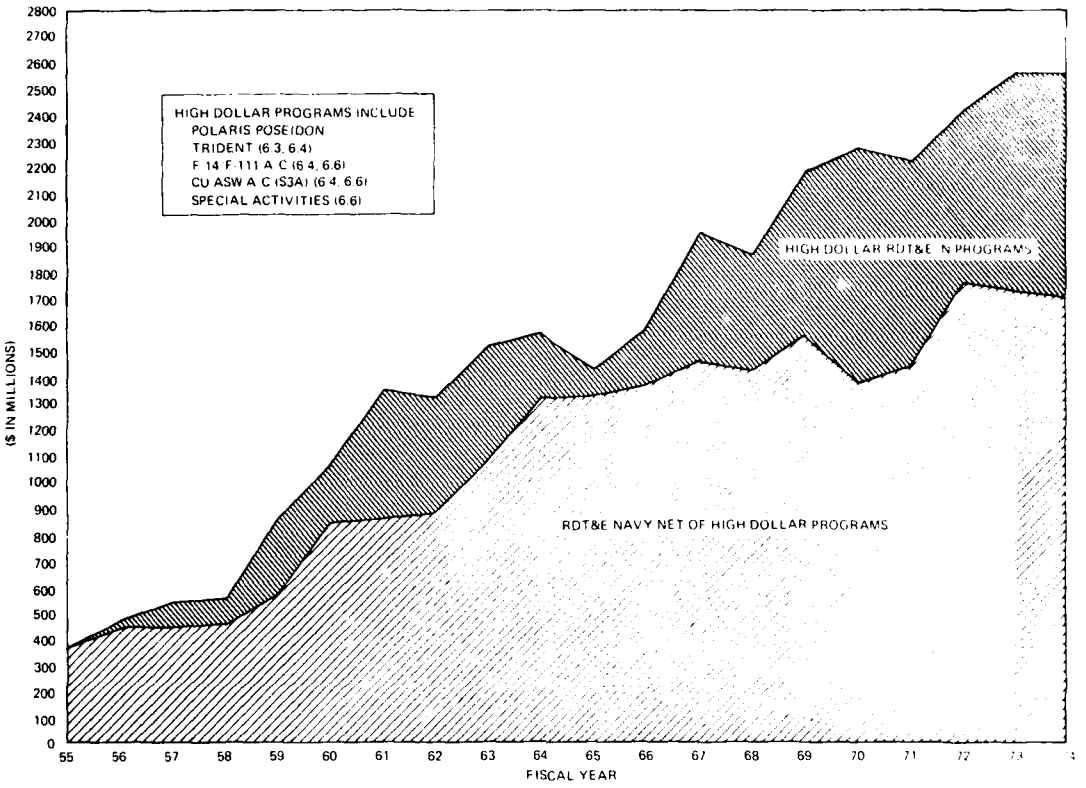
EXHIBIT IV-17
Research and Development Categories as Percent of Total RDT&E,N Appropriation FY62-FY73



Note: These amounts are derived from the past year columns of the various Congressional Budget Submissions and are not precisely consistent with New Obligational Authorizations. The difference results from reprogramming between program years, permitted in "no year" appropriations. The data for each fiscal year's program is the latest category distribution developed for budget presentation and best reflects actual relative dollar size of the various categories for each fiscal year. FY 1962 was the first year in which this category classification scheme was systematically applied.

Source: Thomas Leckey, Assistant Comptroller for Budget and Reports ONR, in letter of 24 December 1974.

EXHIBIT IV-18
High Dollar Programs–RDT&E,N Appropriation
FY55-FY73



SOURCE ONR CODE 520 (ANALYSIS FOR CONGRESSIONAL SUBMISSION, AS AMENDED, 23 MARCH 1961 AND RDT&E, N SUMMARY, 1973)

PART V

PROGRAM EXECUTION

Parts III and IV of this Review dealt primarily with the processes through which program objectives were established and funds were made available to support them. This fifth and final part is concerned with program execution, the process directed toward achieving approved objectives within the resources made available for that purpose. In the Navy Department, this involved developing and maintaining project plans, assigning work to in-house performers, establishing and administering R&D contracts/grants, and providing appropriate direction and control. In addition, headquarters personnel were expected to evaluate project results, make recommendations concerning follow-on projects or acceptance of equipment for fleet use, and ensure an orderly transition to production. Most of the scientific and engineering work, however, was performed where experimental facilities were available in Navy laboratories, field activities, industrial firms, and educational institutions.

In contrast to R&D program planning and budgeting in which both OPNAV and OSD assumed prominent roles early in the era, program execution in the Navy Department during the first decade was virtually the exclusive domain of the material bureaus and offices. OPNAV concentrated on determining what was needed, and the bureaus determined how to provide it; each bureau/office was free to execute its R&D program in a manner best suited to its product line. As the end of the first decade approached, however, substantial changes were emerging. Some of these changes were attributable to the accelerated pace of technology, the concomitant complexity of defense hardware, and troublesome organizational interfaces, all of which contributed to increased emphasis on the "systems approach." Other changes were manifestations of the trends toward centralized direction and control, organizational specialization, and program compartmentalization described earlier.

In the first of the three following chapters, R&D program execution in the Navy Department is presented in the form of a 10-year baseline during which basic patterns, once established, remained relatively stable. The remaining chapters examine the principal changes that occurred during the last years of the era. The changes are presented in two chapters: one dealing with execution of system development projects and the other with execution of research and exploratory development.

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CHAPTER 15

PROGRAM EXECUTION DURING THE FIRST DECADE

In 1946, the bureaus were adjusting to peacetime operations, and the Office of Naval Research (ONR) was being established. Congress was conducting hearings on peacetime procurement practices, including the question of authority to negotiate R&D contracts.

By the end of the year, the basic postwar patterns of program execution were established, and they remained relatively stable for approximately a decade from 1946 to the mid-1950's. Changes that did occur were gradual and were generally less significant than variations among bureaus and offices or even among projects in the same bureau or office. The first two sections that follow highlight these variations first, in terms of the three fundamental categories of R&D effort, and second, in terms of variations among the technical bureaus. A final section describes the patterns of R&D contracting as they emerged during the first decade.

VARIATIONS AMONG R&D CATEGORIES

It was not until the late 1950's that the Navy RDT&E program was formally structured into categories that paralleled the classical R&D spectrum from basic research to hardware development. This action, however, simply ratified a distinction reflected in R&D management practices of long standing. One simply did not manage all categories of the RDT&E program in the same way. The variations among categories of R&D effort are further illustrated in the subsections below.

Executing the Naval Research Program

As noted earlier (Parts I & III), the Chief of Naval Research was responsible for coordinating the Naval Research Program, which consisted of both basic and applied research sponsored by ONR and the bureaus. In planning its early program, ONR had access to a number of the nation's leading scientists who were familiar with Navy problems because of their wartime experience. They urged that a substantial portion of ONR's resources be devoted to basic research in the interest of the long-range military strength of the Navy as well as the nation. Following their advice, ONR placed as much as

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one-third of its total funds in basic research and became a major national factor in this field.[1] Navywide funding of basic research (FY52-FY61) is depicted in Exhibit V-1.

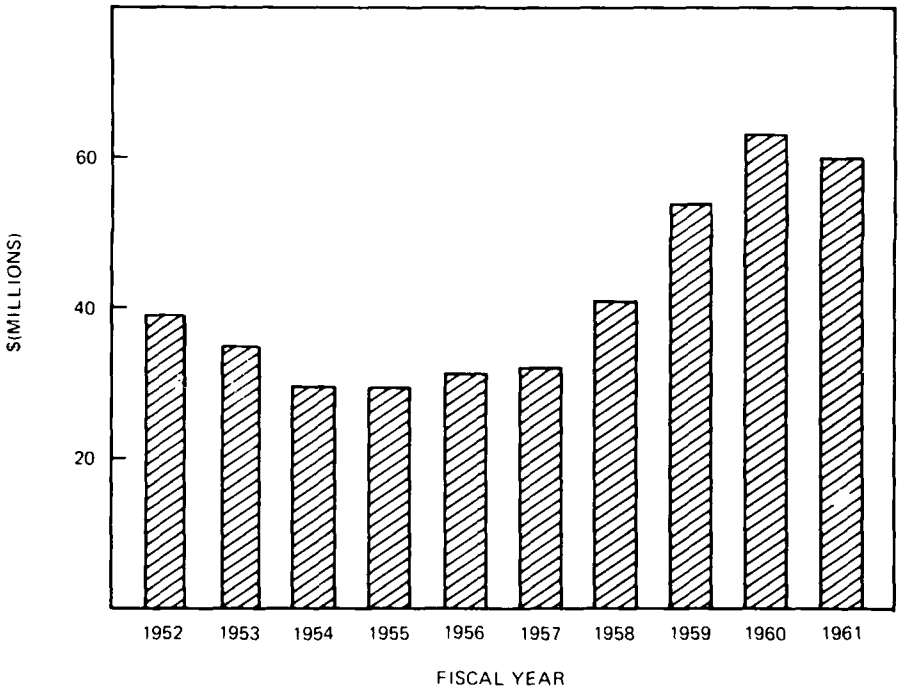
Basic research tasks could not be defined and scheduled with any degree of precision, nor was there any need to do so. Such tasks did not have to mesh with plans for hardware production or fleet introduction, and the maintenance of scientific freedom was of utmost importance in the search for fundamental knowledge. Consequently, ONR's philosophy was to place heavy reliance on the "competent individual" in identifying the work to be done. The philosophy was aptly characterized over 10 years later in the NRAC report as follows:

> In those fields of science of greatest potential relevance to the missions of the Navy, the surest path to progress in basic research is to secure the services of the most competent scientists within the field. Heavy reliance must be placed upon their judgment. Often they are the only ones possessing the vision or the curiosity to suggest initiation of research projects necessary to the creation of certain new and useful facts. Navy awareness of the importance of seeking out top scientists for participation in its basic research program has proven invaluable.[2]

At the beginning of each year, ONR examined its program for balance of effort among the various scientific and engineering disciplines of interest to the Navy, the maintenance of in-house technical competence, and utilization of the best available scientific talent. Gradual shifts in emphasis were made from time-to-time as the technology base developed. First consideration was given to maintaining a level of effort in each of the various scientific and engineering disciplines in the Naval Research Laboratory (NRL). Contract research assignments were then made to various universities, industry, and nonprofit research organizations. These assignments were often in response to unsolicited proposals and awarded on the basis of the relative interest of the Navy to the scientific discipline involved, as well as the competence of the individual or research team considered.[3] The university research program was extensive. For example, in 1949, 1200 projects were supported at 200 universities at the annual cost of $20 million. Nearly 3000 scientists and 2500 graduate students were involved.[4]

While control and appraisal of in-house basic research was delegated to the laboratories, ONR's university and contractor programs were monitored by officers, scientists, and engineers within the various ONR branches. They were actively assisted by ONR's branch offices throughout the country and in London. Periodic reporting was required as one of the conditions of each project. Technical appraisal was largely subjective and based on the premise that the best measure of quality was the degree of enthusiasm and acceptance the results received in the scientific and engineering community.

EXHIBIT V-1
Navy Funding of Basic Research
FY52-FY61



SOURCE: PREPARED BY BOOZ, ALLEN & HAMILTON BASED ON DATA PROVIDED BY THE OFFICE OF NAVAL RESEARCH.

While allocation of resources, control, and appraisal of applied research followed the same general pattern as that described above for basic research, there were subtle distinctions. Projects and tasks were usually more precisely defined because applications were more easily identified. The work could be monitored more effectively, and objective criteria for appraising technical results were more available.

Much of the applied research during the first half of the era was handled by the material bureaus. The Bureau of Ships (BuShips), for example, administered sizable programs in materials and electronics research. Again, the first consideration in assigning applied research projects was the maintenance of a viable level of effort at in-house laboratories. Assignments to individual laboratories were made in accordance with the mission of the laboratory and its relative competence for the project or task involved. Assignments to various universities and nonprofit or profit contractors came about as a result of unsolicited proposals or from the desire on the part of a bureau to take advantage of special skills or competence possessed by the contractor in an area of interest to that bureau.[5]

One noteworthy exception to this modus operandi evolved in BuOrd laboratories in the form of Foundational Research. In 1947 NOTS, China Lake, proposed that BuOrd make funds available either as ". . . a certain percentage from project orders or a special allotment of funds which will be under complete control of the station to be used for needed experiments in applied research, special equipment or to fill in a gap when necessary."[6] These funds were to be expended on requirements of the station which had not been specifically directed by BuOrd. For several years thereafter NOTS, China Lake, utilized the device of a "technical overhead" charge on BuOrd project orders to provide discretionary funds for research. This practice was also instituted at NOL, White Oak.

In 1950 BuOrd established a separate allotment for FY51 Foundational Research and technical overhead up to a maximum of 20 percent of NOL's total annual project budget. The Chief, BuOrd stipulated that no less than half of this amount should be assigned for Foundational Research.[7] While there is some uncertainty as to timing, by the early 1950's similar action had been taken with respect to Foundational Research at NOTS. Thereafter, the principle received general acceptance in other bureaus and laboratories.

Executing Technology Programs

Between Naval Research on one end of the R&D spectrum and full-scale development on the other, there were numerous projects that could not be placed in either classification. These were loosely labeled as technology projects and were later to be grouped under the Exploratory and Advanced Development categories. In general, these projects were more clearly focused on end products than research projects but entailed a higher level of technical uncertainty and lower financial commitment than full-scale development.

Technology programs represented a segment of the Navy's R&D program in which the bureaus operated with little or no outside interference up to the late 1950's. Guided only by the most general requirements, bureau personnel relied on official correspondence, discussions with OPNAV, fleet and laboratory personnel, as well as the experience of their own officers and engineers to identify existing and projected Navy problems.

Ideas for solving fleet problems and exploiting technological opportunities were converted into exploratory projects with relative ease. Such projects ranged from little more than applied research conducted in the laboratory with breadboard hardware to experimental vehicles (e.g., aircraft, smallcraft, and hydrofoils). They included work directed toward correction of deficiencies in fleet equipment as well as maintenance of in-house expertise in technical disciplines required to support the fleet.

Project plans, task assignments, and monitoring procedures were generally flexible and tailored to the needs of the individual manager. Some projects ultimately paid off; some did not. Managers attempted to screen out the losers and put money on the potential winners. The winners found their way into full-scale development in various ways. For example, successful demonstration of a new missile guidance concept might lead to a requirement statement for a new missile, followed by a design competition and subsequent system development. Alternatively, a requirement for a replacement fighter aircraft might accelerate application of a new engine. In still other cases, small hardware projects led directly to production of new components and equipment such as bomb racks and accessories. The key to this complex and relatively unstructured process was the responsibility and authority of the bureau chiefs for fulfilling the material requirements of the fleet in their assigned areas of cognizance and their emphasis on the cradle-to-grave engineering responsibility of technical personnel involved.

Executing Full-Scale Development Projects

The principal purpose of Navy R&D was, of course, to develop equipment for the fleet. Thus, full-scale development projects sought to convert experimental findings into preproduction prototypes through an iterative process of engineering and test. Understandably, the execution of these projects varied widely according to the type of equipment being developed, the technological state of the art, the operating practices of the respective bureaus, and the capabilities of individuals involved. Nevertheless, there is little evidence of substantial change in the basic procedures employed during the first decade of the era. In general, the execution of full-scale development projects during the period from 1946 to the mid-1950's can be characterized as follows:

- Execution of full-scale development projects was entirely within the purview of the cognizant bureaus once a decision was made by OPNAV to pursue the development. This principle was nurtured by the bureaus, supported by SECNAV, and respected by the officers in OPNAV.

- Planning and control of the development effort was effectively delegated to project officers and engineers who frequently operated with a great deal of autonomy. Procedural constraints were minimal; each project officer was free to tailor planning and control mechanisms to the needs of his project.

- Much of the development effort focused on components and subsystems that were ultimately procured separately and furnished as government-furnished equipment for installation in ships or aircraft. System integration consisted largely of fitting the various pieces together within the physical envelope of an airframe or hull.

- The bulk of the engineering effort was accomplished by industry under cost-reimbursable contracts. In some cases, technical direction was provided by Navy laboratories. More frequently, it was provided by the bureaus with or without assistance from laboratories.

- Technical control was exercised by bureau review of design data and test results. Contractor tests were normally witnessed by bureau plant representatives.

- Prototype equipment almost invariably underwent a formal Navy technical evaluation by a designated field activity. Based on that evaluation, minor equipments were approved for Service use by the cognizant bureau. Major equipments underwent operational evaluation as a prerequisite to release for Service use by OPNAV.

VARIATIONS AMONG THE TECHNICAL BUREAUS

Over 85 percent of the technology programs and 95 percent of full-scale development was under the purview of the three material bureaus (BuOrd, BuShips, and BuAer).[8] The R&D management approaches of these bureaus were similar in some respects and substantially different in others. Some of these differences were traceable to operating concepts deeply imbedded in the bureau traditions as these organizations had evolved during the previous century. For the most part, however, they stemmed from fundamental variations in the nature of the bureau businesses—the type of equipment they procured and the characteristics of the industries with which they dealt. Consequently, vestiges of these differences remained to the end of the era, even though the bureaus evolved into systems commands and uniformity of approach became a popular dictum of a centralized management structure. The basic variations in R&D management approach that existed in the three technical bureaus are described in the paragraphs below.

Bureau of Ordnance

BuOrd dealt primarily in implements of war that had little or no counterpart in the peacetime civilian marketplace. Historically, these products included mines, torpedoes, guns, fire control equipment, armor, and ammunition of various types. Quality control for high volume production, safety, reliability, interchangeability of parts, and low unit cost were prominent considerations in the design of these products. Consequently, great emphasis was placed not only on preproduction testing as a basis for design approval but also on the development of the specifications, drawings, classification of defects, and

inspection procedures necessary to ensure the quality of production articles. As the post-World War II era opened, the challenges of a new product line, guided missiles, were being superimposed on this traditional product pattern.

During the war, an Assistant Chief for Research had been established and assigned complete responsibility for research and development up to a preproduction prototype; at this point, management cognizance was transferred to the Production Division. Those involved in the development process, however, continued to play a significant role in technical aspects of transferred products by virtue of their interaction with production engineers.

Due largely to the unique military function of ordnance, BuOrd relied heavily on its in-house laboratories and R&D field activities. Among these, the bureau maintained especially close working relationships with the Naval Ordnance Laboratories at White Oak and Corona, the Naval Ordnance Test Stations at China Lake and Pasadena, and the Naval Proving Ground at Dahlgren. Not only did it support a forward-looking Foundational Research program early in the decade, but it also used the laboratories extensively to develop prototypes and provide technical direction to contractors. In addition, BuOrd received substantial support from the Applied Physics Laboratories at The Johns Hopkins University and the University of Washington, as well as the Ordnance Research Laboratory at the Pennsylvania State University.

The numerous government-owned, contractor-operated ordnance production facilities established during the war were in considerable measure retained in the following decade. Thus, the Naval Ordnance Plants in York, Pennsylvania and Forest Park, Illinois, the Naval Gun Factory in Washington, D.C., and others continued to produce, modify, and overhaul ordnance equipments as direct in-house functions of BuOrd. This tended to reinforce the engineering and R&D functions of the in-house BuOrd laboratories since they provided engineering support to the production facility and were, in time, supported by prototype and experimental manufacture by the latter.

While relying heavily on these laboratories for technical support, the BuOrd R&D Division retained authoritative management control over its projects. Program reviews were conducted periodically on-site at the laboratories, and an annual review was held in BuOrd at the time budgets were being formulated. No rigid pattern was developed, however, for the management of individual projects. Except for the insistence of adequate preproduction documentation mentioned earlier, the management approach depended largely upon the style and respective qualifications of those assigned responsibility for the work. Relationships with civilian contractors also depended largely on individual circumstances; however, considerable technical guidance and direction were provided by BuOrd and laboratory personnel as well as the cognizant ordnance field inspector. Assignment of overall technical and management responsibility for the development of a total weapons system to a prime contractor was foreign to the BuOrd operating concept.

Bureau of Ships

Whereas BuOrd dealt largely with high-volume, relatively low-cost expendables, BuShips' products were heavily weighted toward low-volume, long operating life, and high capital investment. Moreover, BuShips dealt with a mature shipbuilding and marine engineering industry with substantial markets in the civilian economy. It was also supported by a sizable in-house industrial base in the Navy's shipyards.

Responsibility for executing R&D programs in BuShips was divided between the Shipbuilding Division and the Electronics Division. Ships were designed and constructed under the coordinating authority of the Shipbuilding Division's "type desk" officers who were forerunners of present-day acquisition project managers. Technical cognizance over the hulls, boilers, turbines, auxiliary machinery, electrical systems, and other components was vested in technical codes of the same division. Radios, radars, sonars, and electronic navigation equipment were typical products of the Electronics Division.

"Cradle-to-grave" engineering responsibility for each of these product lines was a prominent feature of the BuShips operating philosophy. In the Shipbuilding Division, R&D was clearly subordinate to the broader function of design and engineering support of the overall acquisition process. BuShips personnel designed Navy ships, progressing from iterative preliminary designs to contract plans and specifications. The David Taylor Model Basin supported this process by experimenting with new hull forms, testing models of preliminary designs to estimate shaft horsepower required to achieve desired speeds, investigating stability and seakeeping qualities, etc.[9]

While the Navy designed its own hulls and arrangements, major mechanical components were largely selected from those developed by industry. The Boiler/Turbine Laboratory in Philadelphia performed acceptance testing of prototype hardware, fuels, and lubricants designed to fulfill Navy requirements. Other laboratories tested new materials, processes, and auxiliary machinery.

The Electronics Division, on the other hand, was deeply involved in a burgeoning technology which offered unprecedented opportunities for military exploitation. Consequently, the division administered substantial R&D outlays both in industry and at their in-house laboratories. The Naval Electronics Laboratory (NEL) at San Diego, the U.S. Navy Underwater Sound Laboratory (USNUSL) at New London, and the Naval Research Laboratory were the principal in-house laboratories utilized by this division. In general, these laboratories concentrated on conceptual or exploratory development projects or those with sensitive security classification and assisted BuShips in the technical monitoring of contracted effort, including test and technical evaluation of prototype equipment. BuShips project officers and civilian engineers, however, retained direct management control. Contract monitoring consisted of design reviews, meetings, and

witnessing of performance tests at the contractors' plants. Design changes were frequently made "on the spot" during these visits, particularly when engineering practice appeared inconsistent with requirements for reliability and maintainability under fleet operating conditions.[10] Although R&D was emphasized, the principle of "cradle-to-grave" engineering responsibility was preserved in the Electronics Division. R&D was viewed as an integral part of the total acquisition process.

When the post of the Assistant Chief for Research and Development was established in BuShips in 1949, this official was assigned responsibility for coordinating laboratory policy, R&D budgets, and for interagency liaison on R&D matters. In addition, he was responsible for executing certain applied research and development programs such as materials and the nuclear propulsion program (then in its infancy). Responsibility for executing the bulk of the BuShips R&D program remained with the Assistant Chiefs for Ships and Electronics, respectively.

Bureau of Aeronautics

As was the case in the other bureaus, program execution in BuAer was influenced by the specialized nature of its product line and by the industry with which it was associated. Since it was involved in the development and production of manned vehicles, BuAer's engineering functions were similar in many respects to those of BuShips. Indeed, BuAer had originated as a spinoff from the old Bureau of Construction and Repair, that later became a part of BuShips.[11] On the other hand, the postwar period saw a technological boom in virtually all of BuAer's fields of endeavor. The insatiable demands for increased performance and shorter development leadtimes combined with a variety of considerations (such as pilot safety, reliability, maintainability, and high quantity producibility) to force a level of emphasis on system integration that was unique among the bureaus up to the mid-1950's. Moreover, BuAer had entered the field of guided missiles, regarding them as logical extensions to its product line under the label of pilotless aircraft. This, of course, led to the well-known cognizance dispute with BuOrd which considered guided missiles as an extension of its own product line.

BuAer's interest in guided missiles was paralleled by a similar trend in the aircraft industry. This industry had experienced a phenomenal growth during the war, producing over 80,000 aircraft for the Navy alone.[12] Aircraft firms had accumulated a substantial reservoir of technical and management talent capable of coping with complex technical programs. The performance of aircraft had long been critically dependent on the ability of airframe manufacturers to work with suppliers to minimize weight and drag of the final product. Consequently, it is not surprising that BuAer, faced with mounting technical management challenges and decreasing personnel strength, turned with increasing frequency to prime contractors to help solve problems in system integration.

As indicated earlier (Chapter 3), the apparent uncertainty concerning the advisability of organizational separation of R&D from "design and engineering" was resolved by BuAer in favor of the principle of "cradle-to-grave" engineering responsibility under the Assistant Chief for R&D to whom a number of coequal divisions reported.

Responsibility for executing aircraft and guided missile system development projects resided with "clask desk" officers in the Aircraft and Guided Missiles Divisions. Project officers reporting to the class desk officers coordinated all aspects of the work on their assigned projects, including project planning, preparation of specifications, budgeting, design approvals, progress reviews, and test and evaluation. Typically a new model aircraft or guided missile would evolve through an iterative process of preliminary designs by the Research Division, ideas submitted by industry, discussions with component division personnel, and meetings with representatives of OPNAV. The products of these meetings and discussions were an Operational Requirement and preliminary development specifications. These specifications formed a basis for a design competition that was conducted by the "class desk" officer with the assistance of team members representing all of the other divisions involved. Once a contract was negotiated and awarded to the winning firm, team members monitored progress in their respective areas of technical expertise, participating in periodic design reviews and mockups, as well as reviewing test results for design approval. In-house laboratory personnel were assigned to augment the technical skills of bureau personnel, as necessary, in this monitoring, test, and approval sequence. Ultimately, experimental models of aircraft and guided missiles underwent technical evaluations at the Naval Air Test Center, Patuxent River, or the Naval Air Missile Center, Point Mugu, California, respectively. Production prototypes of aircraft subsequently underwent Board of Inspection and Survey (BIS) trials.

The "class desks" were supported in these enterprises by technical personnel in both functional and component divisions. BuAer's Evaluation Division was an example of a functional division. Staffed, in part, by aeronautical engineers who had served their apprenticeships during the war in the Naval Aircraft Factory, Philadelphia, it played a key role in the conduct of aircraft design competitions.

Component divisions, on the other hand, each had similar "cradle-to-grave" engineering cognizance over various component product lines such as power plants, electronics, and armament.

As might be expected, program execution varied substantially among the component divisions. For example, several factors contributed to the unique procedures followed in aircraft engine development. First, engine development historically led aircraft development by several years. Those few cases where aircraft projects were initiated before successful development of its engine was assured resulted in costly delays and compromises. Second, most engines found applications in civil aircraft as well as in the military.

Third, the reliability of aircraft engines was vital to safe aircraft operations, a consideration that led to exhaustive testing before an engine was accepted for Service use. Consequently, aircraft engine development was not only very expensive, but it was also highly specialized and proprietary. Government/industry R&D cost-sharing and development for joint Service requirements were common practices. Navy in-house effort was directed primarily at preliminary designs, specification preparation, contract monitoring, and test operations.

The Electronics and Armament Divisions, on the other hand, presided over a program composed of a multiplicity of projects ranging from "black box" development of communications, radar, fire control systems, bomb racks, etc., to be furnished as GFE for installation in aircraft, to expendable stores, and missile guidance and control systems as well as electronic test equipment. These projects frequently originated in BuAer laboratories such as the Naval Air Development Center, and followed an orderly progression from preliminary design to breadboard model, laboratory model, and preproduction prototypes upon which a production specification would be based. Just as frequently, the entire development process would be accomplished by industry and monitored by BuAer engineers with the assistance of in-house laboratory personnel.

Among the component divisions, the principle of "cradle-to-grave" engineering responsibility was especially prominent in the Airframe Design Division. Within this division, the same small group of engineers sponsored research in aerodynamics, hydrodynamics, and structures while maintaining close working relationships with the National Advisory Committee on Aeronautics under whose auspices the bulk of the fundamental research in these and related fields was conducted. In addition, they were responsible for reviewing and approving the aerodynamic and structural aspects of all specifications, contractor designs, and engineering change proposals. They also monitored the structural fatigue life of fleet aircraft. Thus, close coupling between research, technology, and full-scale development was virtually automatic, and the technologists were intimately familiar with problems encountered in Service use.

RESEARCH AND DEVELOPMENT CONTRACTING

Prior to World War II, the Navy had no express authority to negotiate research and development contracts. Such contracts could only be negotiated by showing that procurement by formal advertising under existing statutes was impracticable. During the war such authority was granted under the First War Powers Act. Withdrawal of that procurement authority after the war would have meant a return to the rigid rule of advertised procurement designed for regular commercial purchases. The Act of August 1, 1946, which established ONR, authorized the Secretary of the Navy and, by direction of the Secretary, the Chief of Naval Research and the chiefs of the bureaus to enter into contracts for research. The Secretary promptly granted this authority to the Chief of

Naval Research but not to chiefs of bureaus. While the bureaus were not precluded from contracting for research by virtue of implied authority in other statutes, their legal position was not fully clarified until the passage of the Armed Services Procurement Act of 1947.[13]

The freedom to negotiate R&D contracts was critical to the effective utilization of industry and educational institutions in defense R&D. This was recognized in the hearings on proposed postwar legislation by the conclusion that in research and development contracts:

> The contractor must be selected for his reputation, skill, or exceptional facilities in much the same manner that an individual would seek an expert's services or professional advice. Moreover, in procurements of this type, accurate forecasts of costs are in many instances impossible, making it necessary to let such contracts upon an actual-cost basis. In such circumstances the contractor's reputation for integrity and fair dealing becomes a factor of greater importance than it ordinarily is in the awarding of fixed-price contracts.
>
> Furthermore, the very nature of a research and development contract is inconsistent with the theory of formal advertising. . . It is generally impossible to state the nature of the work in precise detail. Only the ultimate objectives and the general scope of the project can be outlined. Such description of the work to be done is clearly inadequate for use in connection with formal advertising.[14]

Relevant Provisions of the Armed Services Procurement Act

The Armed Services Procurement Act established 17 exceptions to the general rule that defense procurement be accomplished through the rigid practice of formal advertising (See Exhibit V-2). Although Exceptions 2 and 10, among others, were used occasionally for research and development, Exceptions 5 and 11 were most relevant. Exception 5 authorized negotiation of contracts for services to be rendered by any university, college, or other educational institution. Exception 11 authorized negotiation if the Secretary determined that the contract was for experimental, developmental, or research work, or for making or furnishing property for experiment, test, development, or research. In the case of contracts not exceeding $25,000, the Chief of Naval Research or chiefs of bureaus could make the determination.[15] For contracts exceeding that threshold, Requests for Authority to Negotiate/Determinations and Findings (RANs/D&Fs) were forwarded to the Office of the Secretary for approval.*

* In 1962, the threshold was increased to $100,000.[16]

EXHIBIT V-2
Exceptions to the Rule Requiring Formal Advertising

1.	A national emergency
2.	Public exigency
3.	Purchases not in excess of $2,500
4.	Personal or professional services
5.	Services of educational institutions
6.	Purchases outside the United States
7.	Medicines or medical supplies
8.	Supplies purchased for authorized resale
9.	Perishable or nonperishable subsistence supplies
10.	Supplies or services for which it is impractical to secure competition by formal advertising
11.	Experimental, developmental, or research work
12.	Classified purchases
13.	Technical equipment requiring standardization and interchangeability of parts
14.	Technical or specialized supplies requiring substantial initial investment or extended period of preparation for manufacture
15.	Negotiation after advertising
16.	Purchases in the interest of national defense or industrial mobilization
17.	Procurement otherwise authorized by law, e.g., architectural or engineering services for preparing specifications for public works, utilities, naval vessels, or aircraft construction

Source: Armed Services Procurement Regulations.

The Armed Services Procurement Regulations, issued in implementation of the Armed Services Procurement Act, were established to provide uniform policies and procedures for guidance of procurement personnel within the Department of Defense. These regulations, Navy Procurement Directives, and other administrative procedures were, however, designed primarily for production procurement and tended to submerge and obscure special authorities or provisions for R&D. Moreover, the secondary position of R&D (from a dollar standpoint) in the procurement process relegated it to a secondary position in resolving departmental policy and procedure.[17] Consequently, few innovative changes in R&D contracting were made during the first decade, once the initial policies were established.

R&D Contracting in ONR

In the early days of ONR, it was found to be mutually advantageous to educational institutions and to ONR to utilize a master contract containing required clauses and to issue thereunder task orders containing the scope of work, funding, and period of performance. That system continued to be ONR's principal method of contracting with educational institutions throughout the era.[18] In other cases, conventional cost-reimbursable (cost-plus-fixed-fee, cost-no-fee, and cost-sharing) and fixed-price contracts were employed. The latter were used primarily on small research tasks when it was possible to make a fairly close estimate of costs to arrive at a reasonable contract price.

Because of the specialized nature of its contracting role, ONR quickly established a reputation for flexibility and timeliness in executing contract agreements. During the first decade and later, it was not unusual for OPNAV and other senior staffs to turn to that office to avoid delays and red tape inherent in contracting offices of other agencies. Sometimes the bureaus provided tasks and funds to add on to an ONR contract because of shorter contracting leadtime.

R&D Contracting in the Bureaus

In the bureaus, cost-reimbursable contracts were also prevalent, although cost-plus-fixed-fee was the most popular form. Many bureau R&D contracts, particularly those for full-scale development of major end items, resulted from a formal competition among two or more firms. A "request for proposal" would be issued to qualified contractors and, when proposals were received, bureau personnel with relevant specialties would evaluate them. Negotiations would then be conducted with those firms whose proposals were considered technically acceptable and whose costs fell within a reasonable range.

Frequently, negotiations would be undertaken first with the firm submitting the best overall proposal, with the other "acceptable" proposals held in reserve as a hedge against failure in negotiations. Negotiations focused largely on performance, schedules, and costs. Cost negotiations were directed primarily at establishing the percentage fee to be allowed and a reasonable estimated cost upon which to base that fixed fee. It was widely recognized that estimated costs in such circumstances were inexact, and an astute project officer budgeted for overruns accordingly.

For small research and technology contracts, competition was normally much more informal. Since it was often the performer, not a specific technical approach, that was being selected, the best qualified by virtue of knowledge in the subject, previous work in the area, and special expertise were prominent considerations. Such qualifications usually evolved through close association with Navy problems, continuing dialogue with bureau

personnel, and independent R&D by the firms in question. It was not uncommon for highly creative effort undertaken at the initiative of these firms to result in sole source awards in response to unsolicited proposals.

In contrast to ONR, however, R&D contracting in the bureaus was generally slow and cumbersome. R&D represented a small percentage of bureau procurement workload and it frequently took a back seat to large, high-priority production contracts. Moreover, procurement personnel were generally trained and oriented to handle production contracts and, therefore, often failed to exploit fully the flexibility permitted under the regulations for R&D contracts. On the other hand, it should be pointed out that many development contracts were inherently more complex than their research counterparts.

In the years that followed, contracting practices for naval research and exploratory development changed very little. In the field of systems development contracting, however, significant changes were affected. These are addressed in Chapter 16.

Notes to Chapter 15

1. Arthur D. Little, Inc., "Basic Research in the Navy," A Report to the Naval Research Advisory Committee, Vol. I (June 1, 1959) p. 14.

2. Ibid., p. 37.

3. Department of the Navy, *Review of Management of the Department of the Navy: Research and Development Management Study*, Vol. II, Study 3 (Washington, D.C., October 19, 1962), NAVEXOS 2426B-3, pp. 148-151 (hereinafter cited as *Dillon Board*).

4. Office of Naval Research, *Annual Report*, 1949 (Washington, D.C. 1950), p. 2.

5. Personal Interview.

6. Naval Ordnance Test Station (Inyokern), Minutes of The Research Board Meeting, 14 November 1947.

7. Joe Smaldone, "History of Naval Ordnance Laboratory" Unpublished draft manuscript Washington, D.C., 1975, no pagination.

8. Based on analysis of the Navy Research and Development Program Budget - FY 1959.

9. Julius A. Furer, *Administration of the Navy Department in World War II* (Washington, D.C., 1959), pp. 352-362.

10. Personal Interview.

11. Furer, *Administration of the Navy Department*, pp. 352-362.

12. Ibid., p. 397.

13. Department of the Navy, Office of the General Counsel, *Navy Contract Law*, 2nd Edition, (Washington, D.C., 1959), NAVEXOS P1995, pp. 406-409.

14. Edwin P. Bledsoe and Harry I. Ravitz, "The Evolution of Research and Development as a Procurement Function in the Federal Government." *The Federal Bar Journal*, XVII, No. 3 (July-September 1957), pp. 189-215.

15. *Navy Contract Law*, p. 419.

16. Public Law 87-653, Section 1(g), 76 Stat 529.

17. Bledsoe and Ravitz, "The Evolution of R&D as a Procurement Function in the Federal Government," pp. 189-215.

18. Office of Naval Research, *Annual Report, 1971* (Washington, D.C., 1972), p. 3.

CHAPTER 16

EXECUTING SYSTEM DEVELOPMENT PROJECTS CIRCA 1955-1973

By the early 1950's, important influences were at work on the traditional patterns of program execution. The pace of technological development presented opportunities for quantum advances in defense systems, and pressures mounted to shorten development and production leadtimes. Response to these pressures hinged on the ability to achieve close coordination of concurrent development of critical subsystems and components. The problems were particularly acute in aircraft and guided missile development where allowances for weight, space, and aerodynamic drag required close control and where incompatibilities among subsystems could lead to undesirable compromises in performance or time-consuming redesign with attendant cost overruns. Accordingly, the mid-1950's saw a growing interest at all management levels in a more effective "system approach" to the design and development of defense hardware, a trend that had a pervasive effect on Navy R&D management for the remainder of the era.

Emphasis on the "systems approach" led, directly or indirectly, to a number of important changes in project management organization and project planning and control techniques, as well as R&D contracting. These and other changes relevant to the execution of system development projects from 1955 to 1973 are discussed in the sections that follow.

IMPACT OF THE "SYSTEMS APPROACH" 1955-1960

Although the impact of the "systems approach" was substantial, it was not something that appeared suddenly. Instead, it was the product of an evolutionary learning process through which people became increasingly aware of techniques that could and should be employed in the conceptualization, design, and development of complex military hardware. During the late 1950's, this awareness was a prominent factor in changes in bureau organizations, policies, and procedures relevant to program execution which are described briefly in the following subsections.

Bureau Organizational Changes

While organizational changes affecting program execution were minimal during the first decade, special arrangements could be and occasionally were made under exceptional circumstances. For example, the Navy's nuclear propulsion program was given special status as a separate branch in the BuShips Research Division in 1948. This project team subsequently succeeded in producing the first nuclear submarine by 1955, despite numerous interagency hurdles along the way. This provided a graphic illustration of what could be achieved by a dedicated project team once it was assigned responsibility with commensurate authority for a major enterprise throughout its life cycle.*

In the mid-1950's, however, the need for closer coordination of complex system development projects led directly to a number of actions described in Chapter 3. These included the creation of the Special Projects Office for the Fleet Ballistic Missile System in 1955 and the realignment of BuOrd's Research and Development Division along weapons system lines in 1956. In addition BuAer established a Weapons System Officer, reporting to the Assistant Chief for R&D, and program managers in its Plans and Programs Group. Among these, the Special Projects Office was clearly the most dramatic in its demonstration of the merits of intensified management of a major system development program.** Nevertheless, Polaris drew heavily on the human and financial resources of the bureaus, and it was widely recognized that the Navy could not afford to organize many projects in this fashion. Clearly, some compromise between vertical project management structures and functional organization was needed. The shape of this compromise was a matter of top-level concern in the Navy Department for the remainder of the era.

When BuOrd and BuAer were merged in 1959, the systems approach was reflected not only in the R&D group but also in the Office of the Assistant Chief for Plans and Programs to whom program managers reported. For the most part, the early program managers concentrated primarily on the post-R&D phase of projects, including transition to production. Nevertheless, they gradually assumed a more authoritative role in the overall planning and coordination of large R&D projects.

Roles of Contractors and In-House Laboratories

As indicated in Chapter 15, the roles of contractors and in-house laboratories in program execution varied substantially among the respective bureaus. While the laboratories tended to concentrate on research and exploratory development with industry

* For a complete treatment of the nuclear propulsion program see: Richard G. Hewlett and Francis Duncan, *Nuclear Navy 1946-1962*; University of Chicago Press, 1974.

** The organization and operating methods of the Special Projects Office are documented elsewhere and will not be repeated here. For further details see: Harvey M. Sapolsky, *the Polaris System Development*, Harvard University Press, 1972.

concentrating on engineering for production, there were notable exceptions to this pattern. Not only did the involvement of Navy contractors in innovative R&D increase substantially during the 1940's and 1950's but many of the laboratories were sometimes deeply involved in full-scale development of fleet hardware. Arrangements varied among individual projects; decisions as to which arrangement to adopt was influenced not only by bureau policy but also by careful consideration of where the required expertise resided. This variation among projects is illustrated in the following brief summaries of laboratory/contractor roles in a few selected projects.

Since several of these projects were initiated during the first decade and were continued during this period, the fundamental patterns described in Chapter 15 are clearly evident. For example, the Sidewinder air-to-air guided missile was an outgrowth of research and exploratory development performed at NOTS, China Lake in the years immediately following World War II. Management and technical direction of the development remained at NOTS with relatively little industrial participation until the missile approached production in 1954 at which time the Philco Corporation was selected as the initial production contractor for the major sections of the missile.[1]

Similarly, the MK 56 and 57 mines had their beginnings in the BuOrd Long-Range Mine Research Program initiated at NOL, White Oak, in 1947.[2] They were subsequently developed by NOL with contractor participation limited to manufacturing.

A different approach was followed with the MK 46 torpedo which was developed under a prime contract initiated in 1958 with Aerojet General Corporation. In this case, NOTS, Pasadena exercised technical direction with its role defined, in part, as follows:

> The agency having technical direction (TD) is responsible to the Bureau for the satisfactory performance of the weapon, its compatibility with related weapons systems, and its overall suitability for naval use. This responsibility, of necessity, carries with it design approval authority assigned to the TD agency by the Bureau of Ordnance. The overall responsibility for the program will remain, however, with the Research and Development Division of the Bureau of Ordnance. . .[3]

Other BuOrd projects during the period followed similar patterns. For example, ASROC was developed with Minneapolis-Honeywell as the prime contractor and NOTS, Pasadena as the Technical Director.[4] SUBROC was also developed utilizing a prime contractor, Goodyear Aerospace Corporation, with NOL, White Oak as the lead laboratory responsible for technical direction.[5] In all of the above cases in which prime contracts were involved, BuOrd retained both fiscal and contract management responsibility.

In contrast to BuOrd, BuShips normally retained responsibility for overall technical direction of system development projects. For example, in the NTDS project initiated in 1956, prime contracts were awarded for the three major subsystems. The UNIVAC Division of Remington Rand was awarded the contract for development of the computer and for system design engineering, the displays were developed by Hughes Aircraft, and the data communications links by Collins Radio. The Naval Electronics Laboratory (NEL) provided engineering and technical support for the entire NTDS program, assuming responsibility for the assembly, test, and evaluation of the developmental model equipments produced under the initial NTDS contracts. NEL also assisted the three major contractors in resolving technical problems encountered during the manufacture of NTDS equipments. In addition, laboratory personnel wrote the technical evaluation procedure for the system, and conducted the technical evaluation of the service test model. Authority for overall technical direction was, however, retained by the BuShips project officer.[6] In another BuShips project, the SPS-48 radar initiated in 1959, Gilfillan was the prime contractor, and the laboratories (NRL and NEL) served principally in an advisory role.[7]

The BuAer approach in subsystem development (e.g., airborne electronics, armament, and aircraft engines) was similar to that of BuShips. BuAer relied heavily on contractors using laboratories to help monitor progress, test and evaluate hardware at various stages in the development, and provide technical advice. Overall technical direction over system development was rarely, if ever, delegated to a BuAer laboratory. This was due in part to the traditional role of its airframe manufacturers—Douglas, Grumman, Martin, McDonnell, Lockheed, and Vought, to name a few—in integrating the various components and subsystems into a final aircraft design.[8]

The accelerated trend toward the system approach in the mid-1950's was most pronounced in full-scale development of aircraft and guided missiles. As they grew more and more complex, it became increasingly difficult to coordinate decisions of separate development organizations so that the components and subsystems fitted together into compatible and effective weapons systems. Reduced personnel ceilings and low civil service pay scales made it progressively more difficult to attract and hold the engineering personnel necessary to perform required systems engineering work.[9] BuAer, and to a lesser extent BuOrd, turned with increasing frequency to weapons system prime contractors for assistance in this function.

In general, three distinct patterns emerged. In some instances, the Navy retained responsibility for contracting for the various elements of the system and for coordinating efforts of the contractors involved, but contracted for assistance in systems engineering. The use of the Johns Hopkins Applied Physics Laboratory for systems engineering in the 3-T surface-to-air missile program was an early example of this approach. In other cases, a system prime contractor was chosen and given the responsibility for system

design, engineering, assembly, and test. In early versions of this approach, the bureaus retained full management responsibility for the system by controlling development schedules, allocating funds, selecting subsystem contractors, and pricing subsystem contracts. Later, the trend was for the Navy to assign greater management responsibility to the system prime contractor and limit the number of associate prime contractors dealing directly with the government. Consequently, a number of subsystem manufacturers became subcontractors to the prime contractor. Under this arrangement, the Navy delegated to the system prime contractor the decisionmaking authority required to manage the day-to-day development of the system, but retained authority to make major decisions, to resolve conflicts between the system prime and certain subsystem contractors, and to review decisions made by the system prime. Development of most aircraft systems as well as air-launched missiles such as Bullpup, Corvus, and Sparrow III followed this pattern in the late 1950's. While a variety of teaming arrangements were employed from time to time, the concept of the weapons system contractor was used with increasing frequency during the remainder of the era.

Project Control

Through the 1950's, project officers had considerable latitude in the methods they employed to plan and control their projects. There were few, if any, handbooks or schools on R&D management and no "standard approach" to project planning and control. Drawing on the experience of their associates and precedents established in earlier endeavors, newly assigned project officers worked with their contractors to develop techniques appropriate to the project in question. Flexibility and utility were prime considerations.

Typically, development projects were planned in phases, starting with broad development specifications and progressing through successive stages of design, fabrication of experimental hardware, and test. As design details were validated, specifications were refined. Ultimately, a preproduction prototype, tested under simulated operational conditions and backed by production drawings and specifications, emerged.

Technical control was exercised through a combination of informal monitoring by members of the project team and review and approval of design data, test procedures, and test results. Schedule control was accomplished by monitoring progress toward specific milestones established in project master plans. Major milestones frequently signalled formal program reviews at the contractor's plant with representatives of the various bureau technical codes and participating laboratories in attendance. The status of work on the project would be presented by the contractor and subjected to critical examination by the project team. Responsibility for followup action on problem areas would be assigned, and plans would be updated accordingly. Cost control was exercised through periodic cost reports required by the contract.

In the late 1950's, the complexities of system development sparked demand for more effective control mechanisms. One of the most widely publicized innovations in this field emerged from the Special Projects Office in the late 1950's in the form of PERT (Program Evaluation and Review Technique) and PERT/COST. These techniques, widely heralded as examples of the innovative management that characterized the Polaris project, soon became standard "tools of the trade."

While the effectiveness of PERT was a subject of considerable controversy among R&D managers in industry and government, there is little question that its introduction represented a significant milestone in the trend toward sophisticated management systems. Prior to that time, one of the principal difficulties encountered by project managers was the correlation between expenditures and technical progress. It was in the area of schedule and cost control that PERT and PERT/COST contributed substantially by providing a technique for work analysis to correlate information on complex programs.

THE SHIFT TO CENTRALIZED SYSTEM PROJECT MANAGEMENT

Emphasis on organizational solutions to system project management problems increased markedly in the 1960's. The Surface Missile System "G" Group was established in BuWeps in 1962, and strengthening of project management was an important consideration in the Navy reorganization of 1963. (See Chapter 6). For the first time a reporting senior other than SECNAV was provided for project managers functioning outside of the traditional bureau structure.

The concept of a centralized management authority for designated projects was given further impetus in 1965 when OSD made it mandatory for all projects of highest priority, as well as those that exceeded $25 million estimated RDT&E costs or $100 million in production investment. In the directive, system/project management was defined as:

> A concept for the technical and business management of particular systems/projects based on the use of a designated, centralized management authority who is responsible for planning, directing, and controlling the definition, development, and production of a system/project; and for assuring that planning is accomplished by the organizations responsible for the complementary functions of logistic and maintenance support, personnel training, operational testing, activation, or deployment. The centralized management authority is supported by functional organizations, which are responsible to the centralized management authority for the execution of specifically assigned system/project tasks.[10]

In addition, the OSD directive prescribed additional policy governing the responsibility, authority, and reporting relationships of system/project managers as well as the initiation, chartering, staffing, and termination of their offices.

In September 1965, the Secretary of the Navy assigned responsibility for establishment and operation of designated projects to the Chief of Naval Material.[11] Later that year CNM issued a comprehensive directive on project management in which he stated:

> The Project Manager is the single central executive responsible for the successful management of the project and accomplishment of the objectives stated in the Project Charter. He has broad directive authority within the scope of the project over the planning, direction, control, and utilization of resources of the approved project and over project efforts of in-house and contractor organizations. As the responsible executive he is expected to act on his own initiative in matters affecting the project. In those cases where action is required which is beyond the authority granted in the Project Charter, he shall refer the action to higher authority with his recommendations, including alternatives available.[12]

The directive further detailed 31 specific duties for which project managers were to be assigned responsibility and commensurate authority. Project managers were, however, required to adhere to established Navy Depart ent policy and procedures including those established by SECNAV, CNM, and bureau chiefs as well as Technical Development Plans and Advanced Procurement Plans, which required approval of higher authority. They were also bound by approved schedules, mission performance, and operational characteristics established by higher authority.

Project managers were normally to be established at the bureau level except in special cases which involved unusual interface or conditions, in which case they were to be chartered by and reported to the Chief of Naval Material. In either case, they were to be chartered at an early stage in a system development and expected to supervise its development, production, and fleet introduction, as well as its logistic support. Consequently, they were accountable for the interphase planning and coordination that had given trouble in earlier years.

CNM-Designated Projects

Not only did project managers' responsibilities transcend R&D, they also frequently encompassed more than one project. This was especially true in the case of CNM-designated projects. Successive models of a system were usually assigned to the project

management office having cognizance over the original version. Thus, the Special Projects Offices evolved into the Strategic Systems Project Office. Others were established at the outset for the avowed purpose of giving top management a single point of contact through which it could exercise authoritative direction and control over generic segments of the program in which more than one system command participated. The Antisubmarine Warfare Project Office was an example of such an office. Of the 22 CNM-designated project managers existing during the period from 1966 to 1973 (Exhibit V-3), less than half could be classified as individual projects in the generally accepted meaning of the word.

The impact of these "program offices" on the flexibility of systems commands in the planning and executing of individual projects was substantial. Not only did they represent an additional layer of control but they also frequently siphoned off scarce technical and management talent that would otherwise have been available to the systems commands. These adverse effects were fully recognized by CNM, and at the turn of the decade a number of CNM-designated projects were either abolished or reassigned to the systems commands.[13]

Project Management in the Systems Commands

Exhibit V-4 provides a list of designated project managers in each of four systems commands (NAVORD, NAVSHIPS, NAVAIR, and NAVELEX) during the period 1966-1973. Managers of these projects were delegated responsibilities and authority comparable to those of the CNM-designated project managers, except on a different organizational plane, reporting to their respective SYSCOM Commanders.

It was explicitly stated in CNM's directive governing project management that project management offices would be staffed with the minimum necessary complement of business and technical management personnel required to fulfill the direct responsibilities of the project manager. Consequently the offices were essentially superimposed over the traditional bureau functional/engineering organizational structure. In NAVAIR, the class desks and component divisions merged with the production division to form a Material Acquisition Group. A similar pattern was adopted by NAVELEX and NAVORD, although in NAVORD the acquisition group comprised three directorates, one for undersea warfare systems, one for surface missile systems, and another for surface warfare systems. In NAVSHIPS the bulk of the technical support was provided by the Naval Ship Engineering Center (NAVSEC) which had been established in 1965. The result was essentially a matrix organization where an individual in a functional group frequently was responsible not only to his superior within his own division but also to one or more project managers. This dichotomy between functional and project responsibilities introduced new organizational interfaces and sometimes led to friction. In most cases,

EXHIBIT V-3
CNM-Designated Project Managers

PM-1	Strategic Systems	1955-
PM-2	Trident	1971-
PM-2	F111B	1963-1969
PM-3	Surface Missile Systems	1964-1969
PM-4	Antisubmarine Warfare	1964-
PM-5	Instrumentation Ships Project Office	1963-1969
PM-6	Automated Carrier Landing System	1964-1971
PM-7	Reconnaissance Electronic Warfare, Special Operations, and Naval Intelligence Processing System	1964-1973
PM-8	Navy Air Traffic Control Beacon 3 System	1963-1968
PM-6/8	Navy Air Control and Identification System	1969-1972
PM-9	Omega Navigation System	1965-1969
PM-10	Fast Development Logistics Ship	1965-1969
PM-11	Deep Submergence Systems Program	1966-1970
PM-12	Inshore Warfare	1966-1969
PM-13	688 Class Submarine	1968
PM-14	Navy Logistic Information System	1967-1969
PM-15	Ship and Air Integration Project	1970
PM-16	Navy Space Project	1970-1973
PM-17	Surface Effects Ships	1970
PM-18	Major Surface Combatant Ship Project	1971-
PM-19	Mine Warfare Project	1972-
PM-20	Antiship Missile Defense Project	1973-

EXHIBIT V-4

Project Managers in Four Systems Commands

NAVSHIPS PROJECT MANAGERS		
PMS-300	Combatant Craft	1971-
PMS-301	1200 PSI Steam Propulsion Plant Improvement	1971-
PMS-302	Sonar	1972-
PMS-303	NATO Patrol Hydrofoil	*1973-
PMS-304	Surface Effects Ship	1971-
PMS-305	Guided Missile Destroyer Ship Acquisition	*1973-
PMS-306	Advanced Logistic Support	1970-
PMS-376	Spanish Ship Support	*1965-
PMS-377	General Purpose Amphibious Assault Ship Acquisition	*1966-
PMS-378	Anti-Air Warfare	1966-
PMS-379	Aircraft Carrier	1966-
PMS-380 (Transferred to PMS-389)	ASW	1966-1973
PMS-381 (Merged with PMS-396)	Submarine Ship Acquisition	1966-1972
PMS-382 (Transferred to PMS-391)	Mine Ship Service and Patrol Craft	*1967-1970
PMS-383 (Combined with PMS-384)	Auxiliary Ship	*1963-1971
PMS-384 (Split between PMS-3004 and PMS-383, 1971)	Landing Ships, Boats, Amphibious Acquisition	1966-
PMS-385 (Merged with PMS-302)	AN/BQQ-2 (Sonar)	*1967-1972
PMS-386 (Merged with PMS-302)	SQS-23 (Sonar)	*1967-1972
PMS-387 (Merged with PMS-302)	SQS-26 (Sonar)	*1967-1972
PMS-388 (Merged with PMS-302)	SISS	*1971-1972
PMS-389	DD-963 Destroyer	*1967-
PMS-390	Underway Replenishment	1967-1971

* Charter date.

EXHIBIT V-4
(Continued)

	NAVSHIPS PROJECT MANAGERS (Continued)	
PMS-391	Oceanographic, Mine Patrol and Special Purpose Ship Acquisition (Merged with PM-5, 1968; Merged with PMS-382, 1970)	*1963-1973
PMS-392	Nuclear Powered Aircraft Carrier	*1968-
PMS-393	688-Class Submarine	*1968-
PMS-394	Acoustic Warfare (Merged with PMS-302, 1972)	*1968-1972
PMS-395	Deep Submergence Systems Project	1966-
PMS-396	Trident	1970-
PMS-397	Ship and Air Systems Integration	1971-
PMS-398	TEMP/REWSON (*Transferred* to PME-198)	1971-1972
PMS-399	Patrol Frigate Ship Acquisition	1971-
	NAVAIR PROJECT MANAGERS	
PMA-231	E2/ATDS	1963-
PMA-232	F-4/Sparrow III	1962-1972
PMA-233	RA-5	1964-1970
PMA-234	A6/EA6	1963-
PMA-235	A-7	1963-
PMA-236	OV-10	1964-1970
PMA-237	A4E/TA4E	1966-1970
PMA-238	Vertical Avionics Shop Test Systems	1965-
PMA-239	F-8	1965-1970
PMA-240	P-3	1965-
PMA-241	F-14/Phoenix	1965-
PMA-242	Anti-Radiation Missile System	1965-
PMA-243	Walleye	1965-1972
PMA-244	S-3A	1966-
PMA-245	Condor Weapons	1966-

* Charter date.

EXHIBIT V-4
(Continued)

NAVAIR PROJECT MANAGERS (Continued)		
PMA-246	Airborne Weapons	1965-1972
PMA-247	Targets	1966-1970
PMA-248	Joint Services Inflight Data Transmission System	1966-1973
PMA-249	Jezebel Sonobuoy	1966-1973
PMA-250	AASW Radar	1966-1970
PMA-251	Igloo White	1967-1971
PMA-252	NIPS [Combined with PMA-253 (Old) and PMA-254 to form PMA-253 (New)]	*1968-1970
PMA-253	Air/Space Electronic Warfare (See PMA-252)	1967-1970 1970
PMA-254	Air/Space Reconnaissance (See PMA-252)	*1968-1970
PMA-255	Assault Helicopter	*1968-1970
PMA-256	Multipurpose Helicopter	*1969-1970
PMA-257	AV-8A (Harrier)	1969-
PMA-258	Harpoon	1969-
PMA-259	Sidewinder AIM 9L	1971-
PMA-260	Carrier Aircraft Support	1971-1973
PMA-261	CH-53	*1972-
PMA-262	Sparrow III	*1972-
PMA-263	Cruise Missile	*1972-
PMA-264	Acoustic Sensors	*1973-
PMA-265	Flighter Modernization	*1973-
PMA-266	Ship and Air Integration	*1973-
NAVELEX PROJECT MANAGERS		
PME-106 (Formerly PM-16)	Navy Space Project	*1973-
PME-107 (See PME-198)	REWSON	*1973-

* Charter date.

EXHIBIT V-4
(Continued)

NAVELEX PROJECT MANAGERS (Continued)		
PME-116	Satellite Communication (Transferred to PME-106)	1966-1973
PME-117	Special Communications	*1967-
PME-118	Naval Telemetry	1967-1970
PME-119	Omega	1965-
PME-121	Navy Special Sensor	*1967-
PME-124	Undersea Surveillance	*1972-
PME-109	REWSON (Merged w/PM-7 to form PME-107)	*1972-
NAVORD PROJECT MANAGERS		
PMO-400	Mk 48 Mod I Torpedo (Combined with PMO-499 to form PWO-402)	*1969-1970
PMO-402	Mk 48 System and Mk 48-0/2 Torpedo (See PMO-400)	*1970-
PMO-403	Aegis/SM-2	*1970-
PMO-404	CAPTOR PAROSS	1970-1971
PMO-405	High Energy Laser	*1971-
PMO-497	Mine Warfare	1968-1969
PMO-498	Mk-46 Torpedo	1968-1970
PMO-499	Mk 48 Torpedo (See PMO-400)	*1969-1970

* Charter date.

however, these problems were resolved routinely. Probably of greater significance was a pronounced shift in emphasis from technical aspects of projects to purely managerial functions. Designated project managers in systems commands, as well as those in the Headquarters, Naval Material Command, were generally accorded priority treatment for the assignment of qualified personnel. These demands, coupled with the effects of other forms of organizational specialization such as the Research and Technology Groups in the systems commands, led to substantial erosion of the level of technical expertise in the Acquisition Groups. Those projects that were of insufficient size or priority to be assigned to a designated project manager suffered accordingly.

Utilization of Contractors and In-House Laboratories

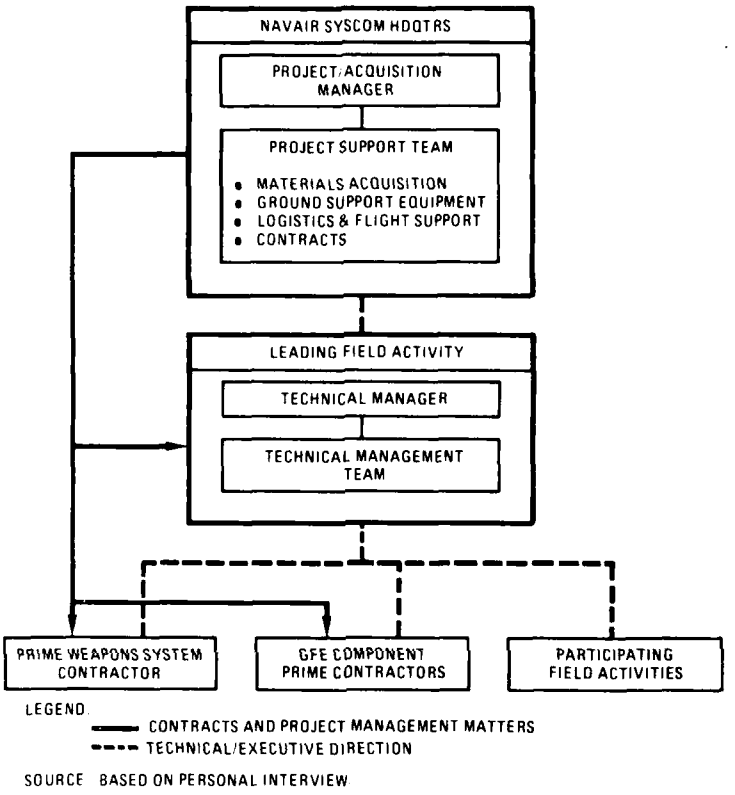
The shift to centralized system project management, coupled with the concomitant change in command relationship of Navy laboratories, had a subtle impact on the way contractors and in-house laboratories were utilized in system development projects. Project managers were much less inclined to be influenced by either traditional bureau patterns or laboratory prerogatives in deciding where work would be assigned.

Nevertheless, traditional patterns continued to be discernible. Aircraft project managers continued to rely primarily on airframe contractors for system integration and day-to-day technical supervision of their projects with Navy laboratories used mostly in an advisory capacity. While in some cases project managers turned to laboratories for technical direction of subsystem development in both aircraft and ships, the practice was most prevalent in the field of weapons development. In this instance, the effect of the earlier BuOrd/BuAer merger was evident as NAVAIR adopted procedures reminiscent of BuOrd. A number of key people who had started their careers in BuOrd remained with NAVAIR when the systems commands were created in 1966. In the face of personnel ceilings and administrative workload, which seriously limited the degree of technical control that acquisition groups could exercise, one in particular, Mr. John Rexroth, initiated the practice of exercising technical direction of major weapons system developments by working with and through a lead field activity. This field activity was made responsible to the NAVAIR project team for management of the technical aspects of the development project. Condor and a follow-on version of Shrike, as well as Standard ARM (Anti-Radiation Missile) and contemporary versions of Sidewinder were developed using this approach which is illustrated schematically in Exhibit V-5.[15]

Despite such measures, internal debate on the question of Navy laboratory participation in system development continued. Some believed that laboratories should be assigned full system/project management responsibilities. Others felt that preoccupation with project administration would erode the technical competence of the laboratories. In a 1971 attempt to resolve the issue through a test case, ASN(R&D) recommended and CNM assigned NOL, White Oak, the responsibility for managing the Captor project. CNM also directed NAVAIR to delegate substantial responsibility and authority for the Agile project to NWC, China Lake (see Chapter 8). Management of Captor subsequently reverted to headquarters and Agile was cancelled. As the era drew to a close, the policy governing the utilization of laboratories in full-scale development was yet to be fully resolved.[16]

A funding overview for Advanced, Engineering, and Operational Systems Development is presented in Exhibit V-6. Laboratory participation in this segment of the Navy's RDT&E program had apparently declined from 37 percent in FY65 to 28 percent in FY73.

EXHIBIT V-5
NAVAIR Management Concept for Weapons System Development Projects



SOURCE BASED ON PERSONAL INTERVIEW

PROCEDURES IMPOSED BY HIGHER AUTHORITY

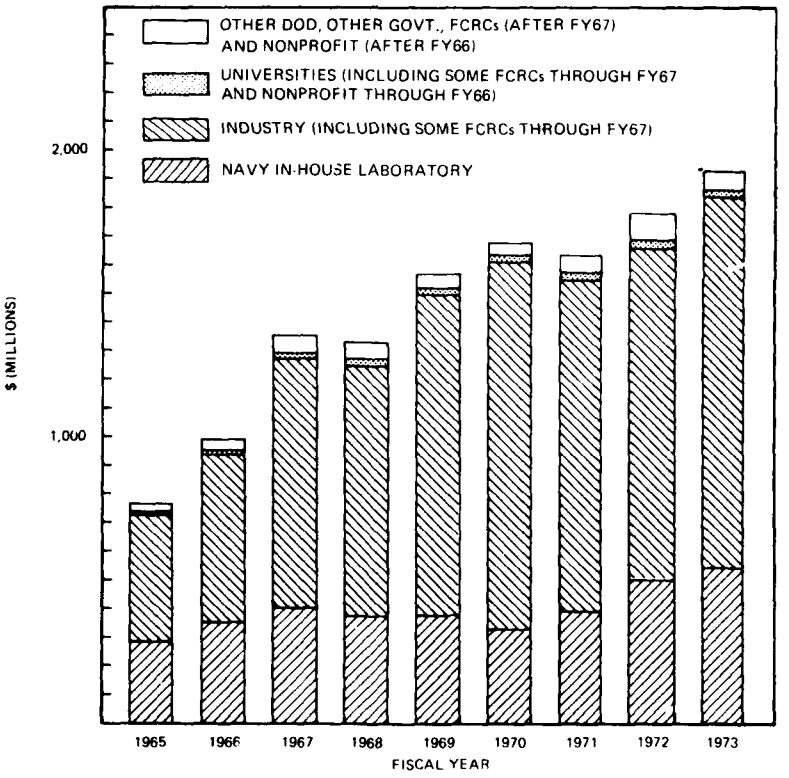
As indicated above, designated project managers were created with the expressed intent of achieving more effective delegation of responsibility and authority. Paradoxically, this move was accompanied by the imposition of increased procedural control to regulate the behavior of those responsible for project execution. Noteworthy examples of such procedures are provided in the following subsections.

Contract Definition

In the early 1960's there was growing concern in OSD with the number of defense contract/program cancellations, large cost overruns, schedule slippages, and shortfalls in

operational performance. Peck and Scherer examined data on 12 major DOD programs of the 1950's and concluded that development costs averaged 3.2 times that originally anticipated, and that development took, on the average, 36 percent longer to complete than was initially estimated.[17] The cost-plus-fixed-fee contract was falling into disfavor on grounds that a contractor performing under that type of contract had little or no incentive to control costs, improve deliveries, eliminate overdesign, or increase system reliability.[18] It was clear, however, that adoption of other forms of contracting (cost-plus-incentive-fee, fixed-price-incentive, etc.) would require much more precision in defining the system to be developed than had been the practice under cost-plus-fixed-fee contracts.

EXHIBIT V-6
Distribution of Advanced, Engineering, and Operational Systems Development Funding Among Performers FY65-FY73



SOURCE: BASED ON DATA PROVIDED BY THE OFFICE OF NAVAL RESEARCH.

In 1961, Secretary of Defense McNamara asked Mr. John Rubel, the Assistant Secretary of Defense for Research and Development, to look into the problems that were plaguing major development projects and to try to find better methods for managing them.[19] This request coincided with a decision to conduct a Phase I study of the proposed Air Force project, Titan III, to carefully analyze alternatives, risks, and performance objectives as a prelude to preparation of performance specifications and definitive contracts.

Following the first experimental use of the technique in Titan III, it was applied to the Army's Lance missile and the Air Force's Mobile Mid-Range Ballistic Missile. Contrary to Titan III, however, the initial phases of these projects were conducted competitively, and the contractors producing the best Phase I studies won the development contracts. In this way, the technique that was to become known as Contract Definition was born.[20]

Early in 1963, the OSD concluded that the Contract Definition technique (known at various stages in its life as Phase I, Program Definition Phase, and PDP) was, indeed, useful for major development projects. Early that year, the Director of Defense Research and Engineering directed that it be applied to all programs in Engineering Development and Operational Systems Development whose anticipated expenditures were at least $25 million in R&D funds or $100 million in investment funds.[21] At the same time, the DDR&E staff started collecting information on the experimental Contract Definition efforts in order to provide guidance on its application.

This guidance was reflected in a DOD Directive that was coordinated with the military departments and the Office of the Secretary of Defense in 1963 and issued in February 1964.[22] The directive was revised and reissued in July 1965 to reflect experience gained in the interim period.[23] The primary features of the process as reflected in the latter directive were:

- Mandatory application of Contract Definition to all major development projects ($25 million or more R&D funds, or $100 million or more investment funds) in Engineering and Operational Systems Development

- Emphasis on the Concept Formulation period that preceded Contract Definition and the "prerequisites" to entering Contract Definition (see Chapter 11)

- Emphasis on competitive Contract Definition as the preferred method, as opposed to sole source or by an in-house laboratory

- Necessity for identifying risks, validating technical approaches, defining the specifications, and getting a good contract (i.e., firm rather than letter-type contract, and fixed-price or incentive type, not cost-plus-fixed-fee).

The overview of the process and its relationship to Concept Formulation is illustrated in Exhibit V-7. As indicated in the exhibit, Contract Definition consisted of three phases. Phase A was the period during which contractors were selected and awarded Contract Definition contracts based on competitive proposals. It started with conditional approval of the engineering development project by OSD based on the results of Concept Formulation and ended with the award of Contract Definition contracts to two or more competing firms. Typically, this phase lasted about 4 months. Phase B started with award of the Contract Definition contracts and ended with the submittal by competing contractors of their reports covering the work and firm proposals for full-scale development. Phase C comprised the period of government evaluation of the proposals, negotiation of changes in the proposed contracts, selection of the contractor, and ratification of OSD's conditional approval for full-scale development.

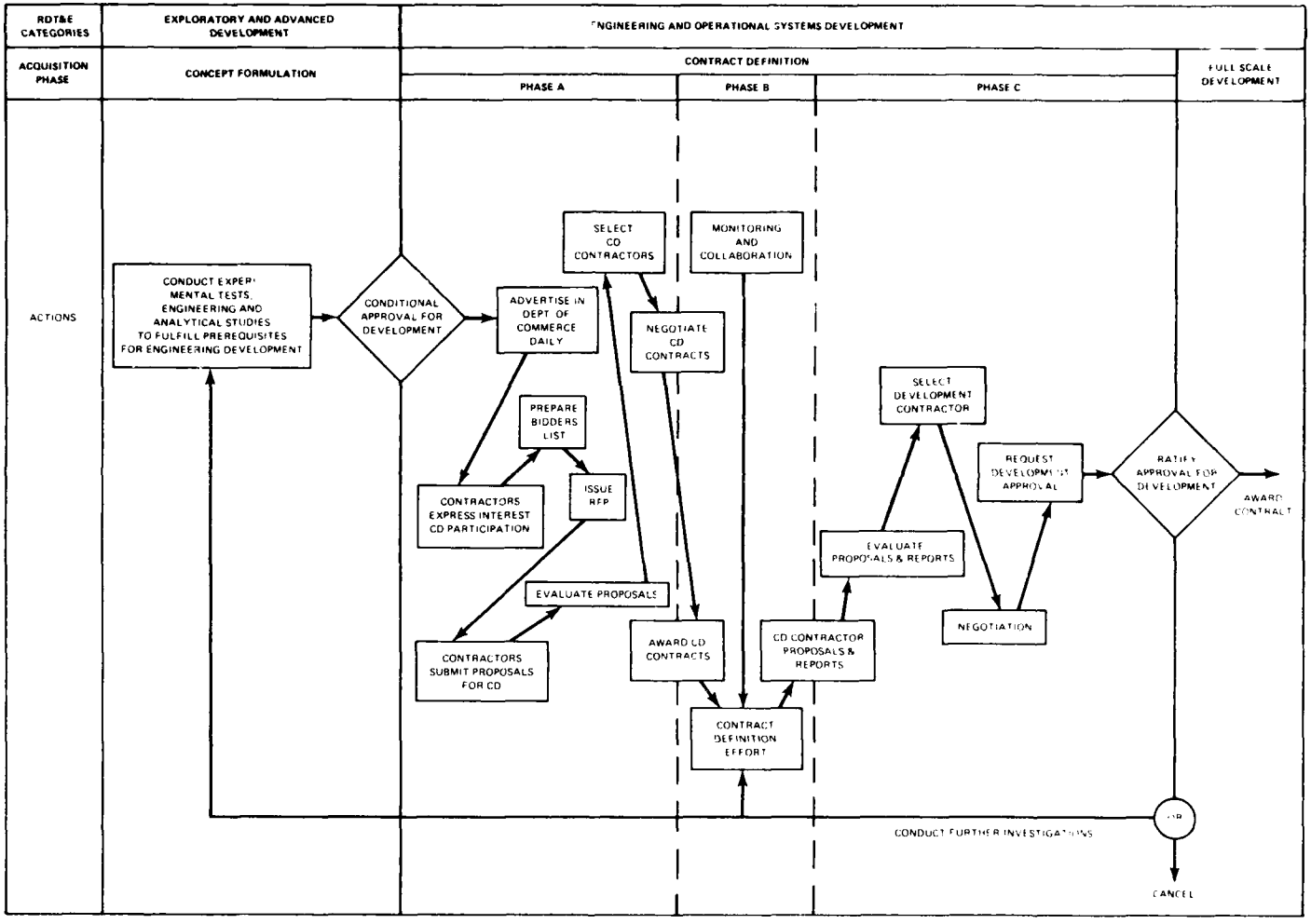
Contract Definition was intended to yield improved specifications, work statements, and cost estimates by exploiting the leverage of industrial competition in the definition process and withholding final approval until OSD was satisfied that these objectives had been achieved. This contrasted with earlier practice in which both technical and cost uncertainties had been more gradually resolved as a function of the development process. While the new process undoubtedly resulted in firmer development specifications, and more definitive contracts, it was not without significant disadvantages.

The question of project delays was probably the most crucial issue. Among the Navy projects using this procedure in the 1960's (Exhibit V-8.), the time consumed by Contract Definition varied between 6 months and nearly 2 years with most requiring approximately 1 year. The problem was exacerbated by excessive data requirements. The quantity of paperwork generated through iterative contractor studies achieved unprecedented levels. The task of assimilating the data in limited time periods taxed the capabilities of government members of project teams, and difficulties were encountered in maintaining contractor teams intact while awaiting Phase C decisions.[24]

Funding of Contract Definition was also a critical problem. While it was OSD policy to fully fund these efforts, this was rarely achieved in practice. Contractors were tempted to "buy in" with the expectation of recouping their investment in follow-on contracts. Moreover, government/contractor relations were especially sensitive during a protracted competition. The government insisted on the right of "technology transfusion" whereby ideas developed by one firm during the government-funded Contract Definition could be transferred to the winner for use in the subsequent development phase. This was clearly a sensitive issue during the competitive phase of Contract Definition.[25]

Despite its problems, proponents of Contract Definition maintained that disadvantages were more than offset by subsequent savings in life-cycle cost and leadtime—a view that was difficult either to support or refute conclusively. In 1971, OSD cancelled

EXHIBIT V-7
Concept Formulation/Contract Definition Process



SOURCE: PREPARED BY BOOZ, ALLEN & HAMILTON INC. WITH REFERENCE TO J.W. GRODSKY'S UNPUBLISHED THESIS (SEE FOOTNOTE 20).

the formal directi[ve] regulating Contract Definition in an effort to reduce unnecessary rigidity. Military d[epartm]ents were encouraged to tailor their procedures to the needs of their respective programs.

EXHIBIT V-8
Navy Contract Definition Projects in the 1960's

Integrated Helicopter Avionics System (IHAS)	Walleye Missile
Integrated Light Attack Avionics System (ILAAS)	Condor Missile
Advanced Surface Missile System (ASMS)	EA-6B Aircraft
MK 48 Torpedo	VSX Aircraft
Fast Deployment Logistics (FDL) Ship	NATO Sea Sparrow Surface Missile System
Poseidon Missile	Target Acquisition System (TAS)

The Defense Systems Acquisition Review Council

The role of the Defense Systems Acquisition Review Council (DSARC) was described briefly in Part III. As indicated, it was the cornerstone of Deputy Secretary of Defense Packard's policy of decentralizing responsibility and authority for executing acquisition projects while maintaining essential control over major decisions. A procedure was established whereby DSARC would review major projects at critical junctures in their development cycle.[26] Three decision milestones for such reviews were established: DSARC-1 for initiation of the project, DSARC-2 for initiation of full-scale development, and DSARC-3 for initiation of production/deployment. The planning document supporting this process was the Development Concept Paper (DCP) that provided primary information and rationale regarding decisions to be made. The Council, chaired by the Director, Defense Research and Engineering, reviewed the issues relevant to the milestone in question and made recommendations to the Secretary of Defense for his decision. An important feature of the approach was the establishment of thresholds in the DCP: thresholds in cost, in schedule, and in performance. As long as it remained within approved thresholds, OSD limited its review to the established milestones. If thresholds were breached or threatened, special action was required.

The new approach was heralded by many as a step in the right direction in that it emphasized the principles of delegation of responsibility and commensurate authority--enabling top-management to determine what enterprises were to be undertaken and operating managers to determine the how. As the era drew to a close, it remained to be seen whether or not these principles would be supported in practice.

Prototyping

In the early 1970's, a new emphasis was placed on development of two or more prototypes for each mission. The best system would then be selected on the basis of proven performance before going into production.[27] This approach was dubbed the "fly-before-buy" concept. In authorizing the fiscal 1972 Appropriation, the Senate Armed Services Committee discussed the prototype strategy:

> At the present time, Department of Defense development procedures are so structured that in each area there is only a single weapon system available to modernize the forces–and this system is often a very costly one. This means that Congress is faced with the decision of approving the procurement of that system or denying modern weapons to our armed forces. The Department of Defense has recently announced certain steps that would begin to correct this tendency, but until it is corrected modernization must go forward with those systems available. It would be far more desirable for the nation to be able to have alternative weapon systems and technical approaches from which to choose those systems best designed to accomplish the most important military missions before a large financial commitment has been made. In this context it is encouraging that the Department of Defense has announced an intention to develop experimental prototypes of new aircraft and other weapon systems and components without a prior commitment to production. This can help provide testable hardware at a lower cost, since an experimental prototype aircraft, for example, need not contain many of the costly electronics and other subsystems which increase the cost of weapon system development under current procedures.[28]

The reader will note that this practice was reminiscent in some respects to that followed earlier by the material bureaus in which several competing projects were carried through the development stage with decision for large quantity production reserved, pending availability of firm experimental evidence based on test and evaluation. As of 1973 there was insufficient experience with the "fly-before-buy" concept in the context of the contemporary R&D management environment to judge its ultimate impact.

Trends in R&D Contracting

Closely allied with Contract Definition during the 1960's was the concept of Total Package Procurement. According to J. Ronald Fox, in *Arming America*, the approach was

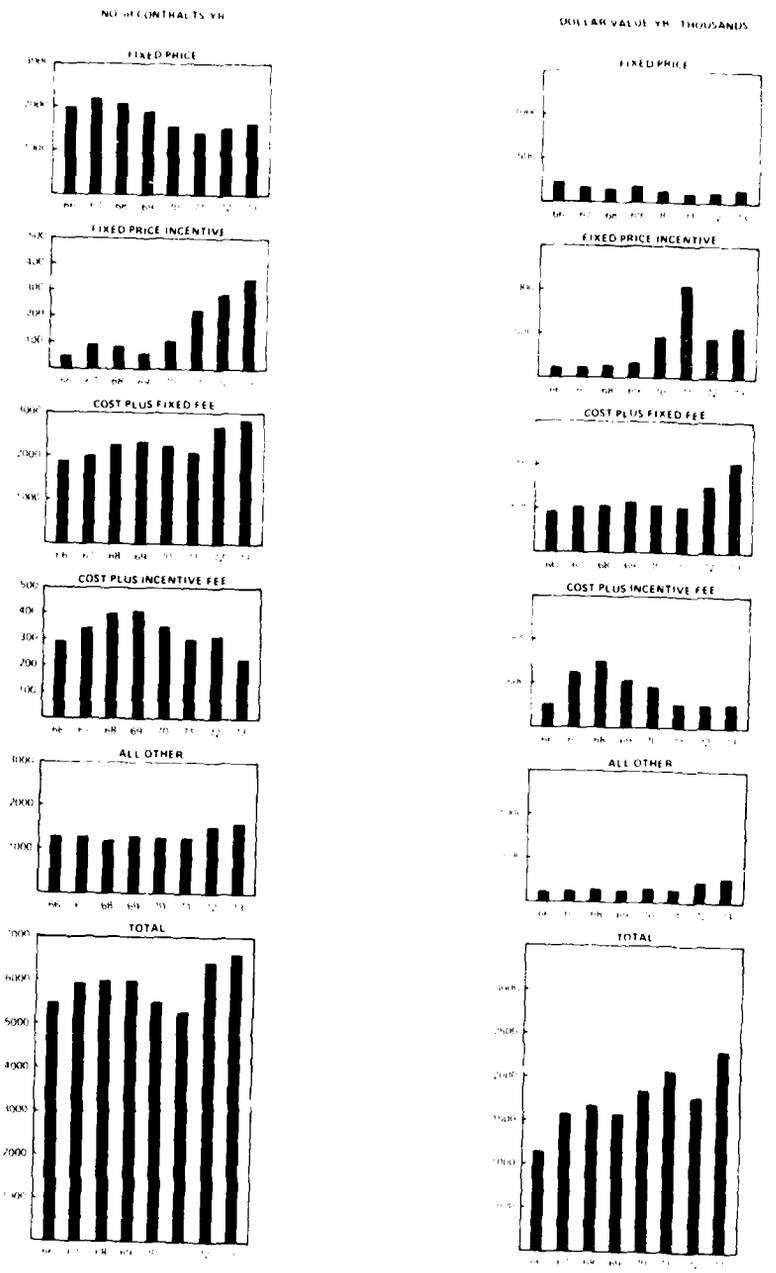
designed by Robert Charles, then Assistant Secretary of the Air Force, in response to the allegation by a number of government and industry officials that the method of defense contracting itself caused contractors to underestimate the cost of development programs. They argued that contractors intentionally underestimated development costs in order to place themselves in a "sole source" position for follow-on production contracts. Under Total Package Procurement, contractors were to be asked to bid on a total program package consisting of the development, production, and spare-part support. The contract, generally a fixed-price incentive type, was to end the need for day-to-day government control of contractors' activities. It offered the government the opportunity to shift the major risk and major program management responsibility to contractors.[29] The concept was not actually employed by the Navy, except in the planning stages. For example, the Fast Deployment Logistic Ship was destined to use Total Package Procurement, but Congress failed to appropriate the money for the project at an early stage. Nevertheless, Total Package Procurement was a prominent issue in the acquisition process until 1972, when the concept was abolished by the Deputy Secretary of Defense.

A basic thrust behind both Contract Definition and Total Package Procurement was the desire to harness the profit motive in industry by subjecting contractors to a system of rewards and penalties dependent on the quality of their product, timeliness of delivery, and effectiveness of cost control. Thus, cost-plus-incentive-fee, fixed-price incentive, and firm-fixed-price contracts were favored. In the late 1960's, yet another contract type was devised, the cost-plus-award-fee. This was an incentive contract in which a minimum fee was established initially. Additional fee could be awarded on the basis of quarterly evaluations of contractor performance, up to a predetermined maximum. Nevertheless, Fox reports a considerable disenchantment with those contract types toward the end of the era and indicates a tendency to revert to the policy of the 1950's—writing separate contracts for development, production, and support and using cost reimbursable contracts for development work.[30]

Exhibit V-9 presents data on R&D contracts awarded by the Navy from 1966 to 1973. While the number of fixed-price-incentive contracts increased steadily, the total dollar volume of that type of contract did not. Moreover, following a dip in 1970 and 1971, the use of cost-plus-fixed-fee contracts was on the rise while both the number and dollar volume of cost-plus-incentive-fee contracts were decreasing.

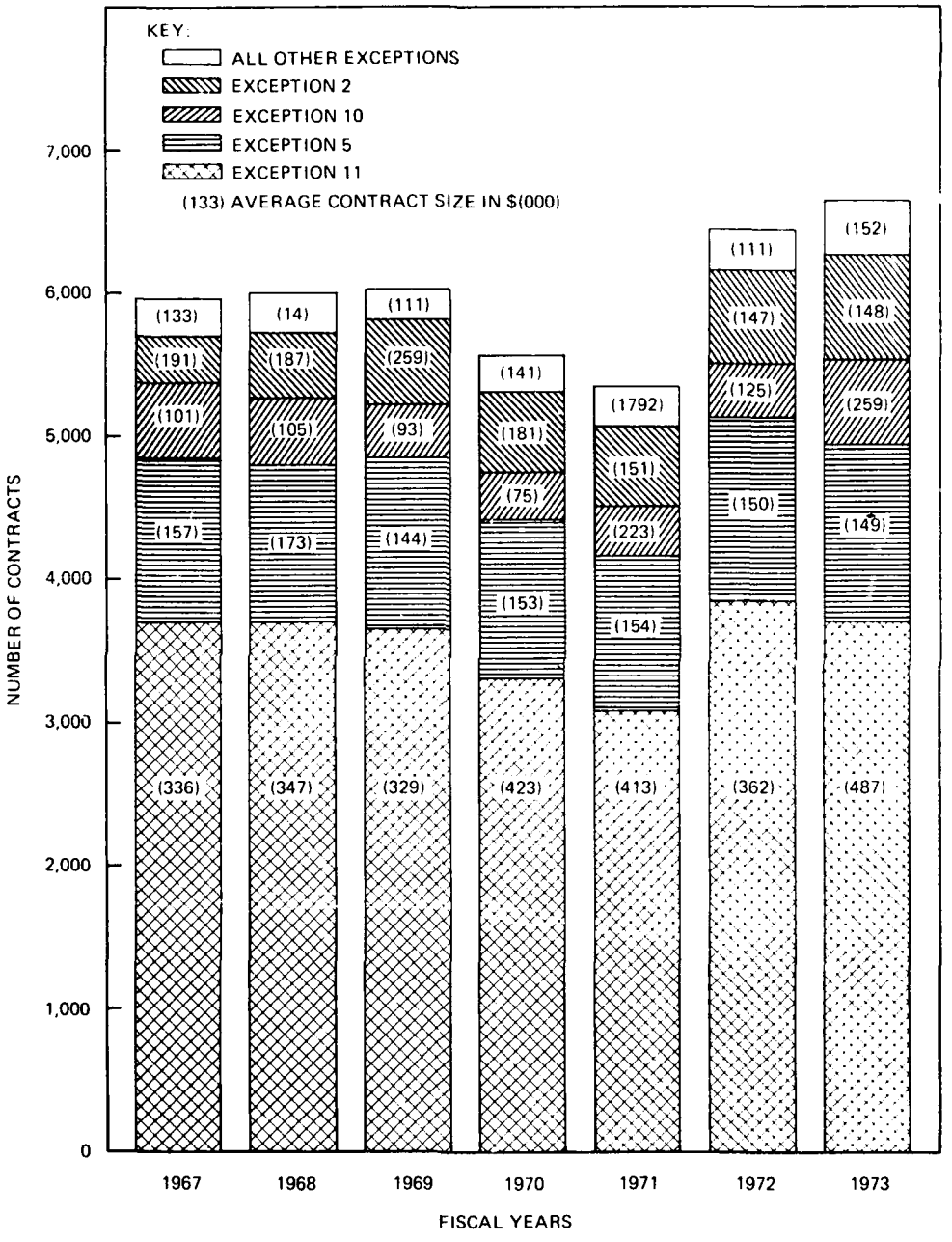
Other characteristics of Navy R&D contracting are evident from Exhibits V-10 and V-11. The former illustrates the preponderance of negotiations authorized under Exceptions 5 and 11 of the Armed Services Procurement Regulations. The latter shows the preponderance of R&D contracts under the $100,000 threshold requiring approval by the Office of the Secretary of the Navy. In this context, the reader should note that the data presented in all of the above exhibits (V-9 through V-11) apply to all categories of R&D effort, not just System Development projects.

EXHIBIT V-9
Trends in Contract Types FY66-FY73



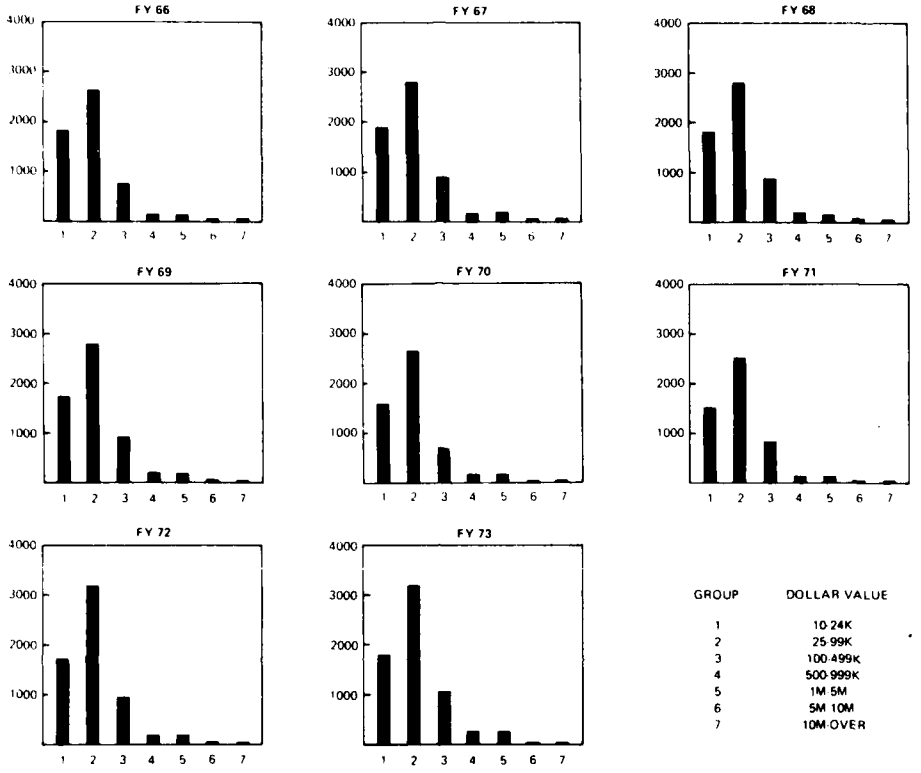
SOURCE: BASED ON DATA PROVIDED BY HEADQUARTERS, NAVAL MATERIAL COMMAND.

EXHIBIT V-10
Utilization of Contract Negotiating Exceptions FY67-FY73



SOURCE: BASED ON DATA PROVIDED BY HEADQUARTERS, NAVAL MATERIAL COMMAND.

EXHIBIT V-11
Number of R&D Contracts vs. Dollar Value FY66-FY73



SOURCE: BASED ON DATA PROVIDED BY HEADQUARTERS, NAVAL MATERIAL COMMAND.

Pervasive Influence of Procedures and Multiple Staff Reviews

Despite the emphasis on delegation of responsibility and commensurate authority, 11 of the 31 responsibilities of project managers cited in the 1965 CNM directive cross-referenced one or more "how-to-do-it" directives or manuals. By 1968, when the earlier directive was revised, no less than thirty such directives were referenced in this context.[31] A further clue to the proliferation of directives may be found in a review of successive editions of the Department of the Navy RDT&E Management Guide. The 1969 edition cited 128 references to official directives and manuals.[32] By 1972, the list had grown to 137.[33]

Project managers were required to prepare a variety of planning documents including:

- Technical Development Plans
- Project Master Plans
- Advanced Procurement Plans
- Configuration Management Plans
- Source Selection Plans
- Contractor Performance Evaluation Plans
- CIR (Cost Information Report) Data Plans
- Transition Plans
- Integrated Logistics Plans.

Each of these plans were reviewed by cognizant staff personnel, and many touched off extensive dialogues with the functional groups involved and reviewing authorities.

In addition, a variety of reports were required. Written reports included Hotline Reports in the event of "significant change" or "breaching of a threshold" and Flash Fire Reports in the case of suspected or verified contract cost increases, Contractor Performance Evaluation Reports, Selected Acquisition Reports, and many others. Project personnel were also called upon to make ad hoc oral reports at the NAVMAT and OPNAV/SECNAV information centers, in addition to various members of the DDR&E staff. Moreover, inquiries of congressional staffs and the General Accounting Office also required high priority attention of project managers. In the Defense R&D environment of the last half of the era, one of the most important functions of the system/project managers was to serve as a buffer between higher authority and the people in the functional groups. The increased demands of Congress, OSD, OPNAV, and others for information, the layering of staffs, and the proliferation of procedures and controls all contributed to the need for single points of contact on important projects. It was not unusual for a project manager to spend over half of his time responding to demands of higher authority for information or justification of his intended course of action.[34] Sometimes these reviews threatened or actually caused delays at crucial points in the project in question. Of necessity, project managers dealt directly with higher levels, keeping their superiors in the chain of command informed as best they could. It was not surprising that some viewed with skepticism the proposed delegation of project management responsibility to in-house laboratories.

Notes to Chapter 16

1. Harbridge House, Inc., *The Sidewinder Case Study*, Prepared for SECNAV Project Working Group, 1970, p. 15. (SECRET).

2. Harbridge House, Inc., *The Mines MK 56 and 57 Case Study*, Prepared for SECNAV Project Working Group, 1970, p. 17. (SECRET).

3. Harbridge House, Inc., *The MK 46 Torpedo Case Study*, Prepared for SECNAV Project Working Group, 1970, p. 37. (SECRET).

4. Naval Ordnance System Command and Naval Air Systems Command, *Resume of Achievement, Bureau of Naval Weapons* (Washington, D.C., 1968), pp. 135-38 (Confidential).

5. Naval Ordnance Laboratory, *SUBROC Project History* (White Oak, Md., 16 December 1968). (Confidential).

6. Harbridge House, Inc., *The Naval Tactical Data System Case Study*, Prepared for SECNAV Project Working Group, 1970, pp. 9, 34. (SECRET).

7. Harbridge House, Inc., *Radar AN/SPS-48 Case Study*, Prepared for SECNAV Project Working Group, 1970, pp. 11, 23. (SECRET).

8. Personal Interview.

9. Personal Interview.

10. DOD Directive 5010.14, Subject: System/Project Management, May 4, 1965.

11. SECNAV Instruction 5000.21A, Subject: Project Management in the Department of the Navy, September 8, 1965.

12. NAVMAT Instruction 5000.5, Subject: Project Management in The Naval Material Support Establishment, December 7, 1965.

13. Personal Interview.

14. Personal Interview.

15. Personal Interview.

16. Personal Interview.

17. Morton J. Peck and Frederick M. Scherer, *The Weapons Acquisition Process: An Economic Analysis* (Boston, Mass., 1962) p. 22.

18. "Incentive Contracting Puts Profit Motive to Work," *Navy Management Review*, VIII, No. 9 (September 1963), pp. 12-13.

19. Robert S. Tucker, "Interpretation of the Program Definition Phase," *Program Definition Phase* (Washington: Department of the Air Force, February 1963), AFSC Report SCCS-36, p. 4.

20. James W. Grodsky, "Contract Definition - A Management Technique for Major Development Projects" (Masters thesis, The George Washington University, June 1969). (This discussion of Contract Definition draws heavily on the material presented in Mr. Grodsky's thesis.)

21. Office of the Director of Defense Research and Engineering, Memorandum, Subject: Management of Research and Engineering to the Secretaries of the Military Departments, January 18, 1963.

22. Department of Defense Directive 3200.9, Subject: Project Definition Phase, February 26, 1964.

23. Department of Defense Directive 3200.9, Subject: Initiation of Engineering and Operational Systems Development, July 1, 1965.

24. Personal Interview.

25. Personal Interview.

26. DOD Directive 5000.1, Subject: Acquisition of Major Defense Systems, July 13, 1971.

27. J. Ronald Fox, *Arming America: How the U.S. Buys Weapons*, (Cambridge, Mass., 1974), pp. 19-20.

28. Ibid.

29. Ibid, pp. 243-247.

30. Ibid, p. 246.

31. NAVMAT Instruction 5000.5B, Subject: Project Management in NAVMATCOM, December 3, 1968.

32. Department of the Navy, *RDT&E Management Guide*, 3rd edition, (Washington, D.C., July 1969), NAVSOP-2457 pp. R1-R5.

33. Department of the Navy, *RDT&E Management Guide, Part I: System Description*, 4th edition (Washington, D.C., July 1972), NAVSOP-2457 pp. Ref 1-Ref 5.

34. Personal Interview.

CHAPTER 17

EXECUTING RESEARCH AND EXPLORATORY DEVELOPMENT 1955-1973

If it were not for the changes in the execution of systems development, the 10-year baseline described in Chapter 15 could easily have been extended another 5 years. There were few noteworthy changes during the 1950's in the way Research and Exploratory Development programs were executed. As the trend toward program compartmentalization and organization specialization accelerated in the 1960's, however, noteworthy changes did occur. In general, these focused primarily on program management matters (e.g., distribution of resources within categories and policy governing utilization of in-house laboratories) rather than management of individual projects as was the case in systems development. This distinction is evident in the sections below which address changes affecting the execution of Naval Research and Exploratory Development, respectively.

NAVAL RESEARCH

The Naval Research program was probably the least affected by the changes instituted during the period. It was, however, subject to increased scrutiny from the mid-1950's on. As noted in Chapter 3, ONR found it necessary to strengthen its coordination of naval research by establishing a Deputy Science Director for Research Coordination in 1955. In 1958, for several reasons, including eliminating potential conflict of interest between those charged with Navy-wide research coordination and those responsible for ONR program execution, this function was transferred to a separate office reporting directly to the Chief of Naval Research. It remained there until it was returned to the Office of the Director of Research in 1963.

In 1962, the Dillon Board identified the following three "perennial problems" associated with the execution of research:

- Maintaining stability of research effort and avoiding radical changes, either up or down, that affect the program adversely

- Maintaining proper balance among the various scientific and engineering disciplines of interest to the Navy

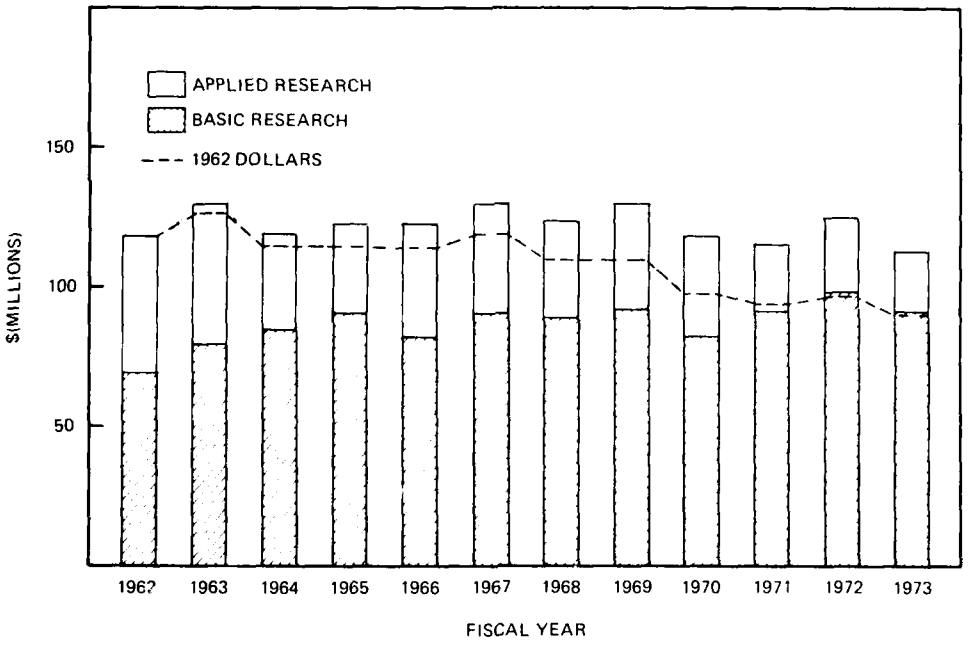
- Ensuring that applicable new knowledge gained through research finds it way into new systems for the fleet.[1]

These problems continued to be of crucial importance for the remainder of the era and are discussed in the paragraphs below.

Research Program Stability and Balance

Funding totals for the Naval Research program from FY62 to FY73 are shown in Exhibit V-12. The marked decline in level of effort during the period, as measured in 1962 dollars, and the increasing percentage devoted to basic research are readily apparent. Exhibit V-13 shows the distribution of research funding among performers. Some decline in industrial and university research is evident from FY65 to FY73.

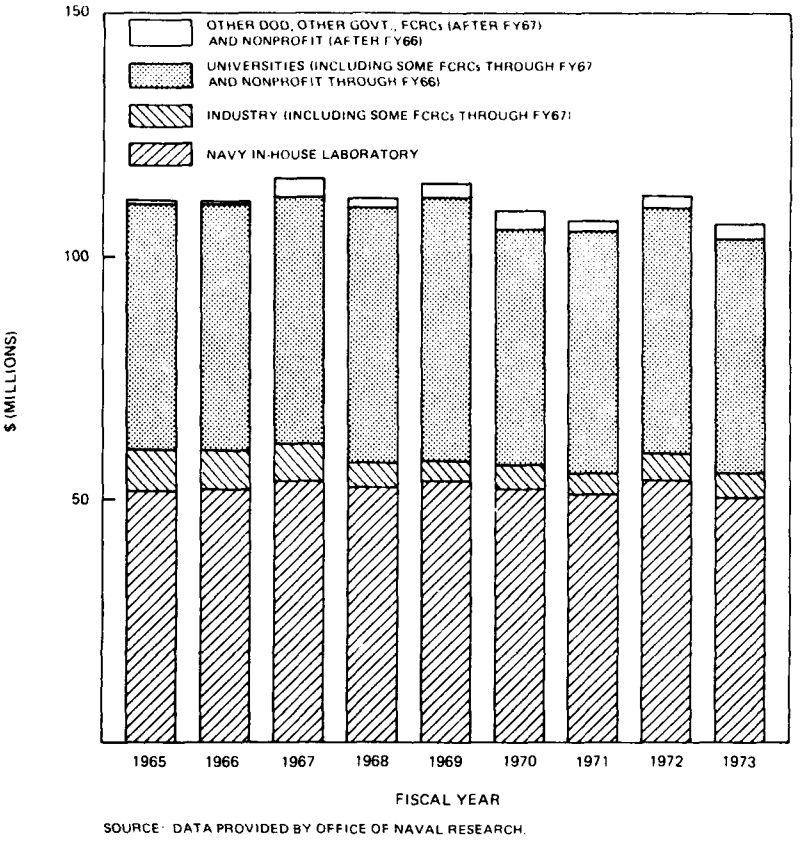
EXHIBIT V-12
Funding Totals for Naval Research Program FY62-FY73



SOURCE: DATA PROVIDED BY THE OFFICE OF NAVAL RESEARCH.

Exhibit V-14 depicts the distribution of resources among the various scientific and engineering disciplines except for laboratory-independent research for which such a breakdown was not available. The most notable trend, evident in the latter exhibit, is the substantial increase in funds allocated to oceanography and compensatory reductions in

EXHIBIT V-13
Distribution of Research Funding
Among Performers FY65-FY73

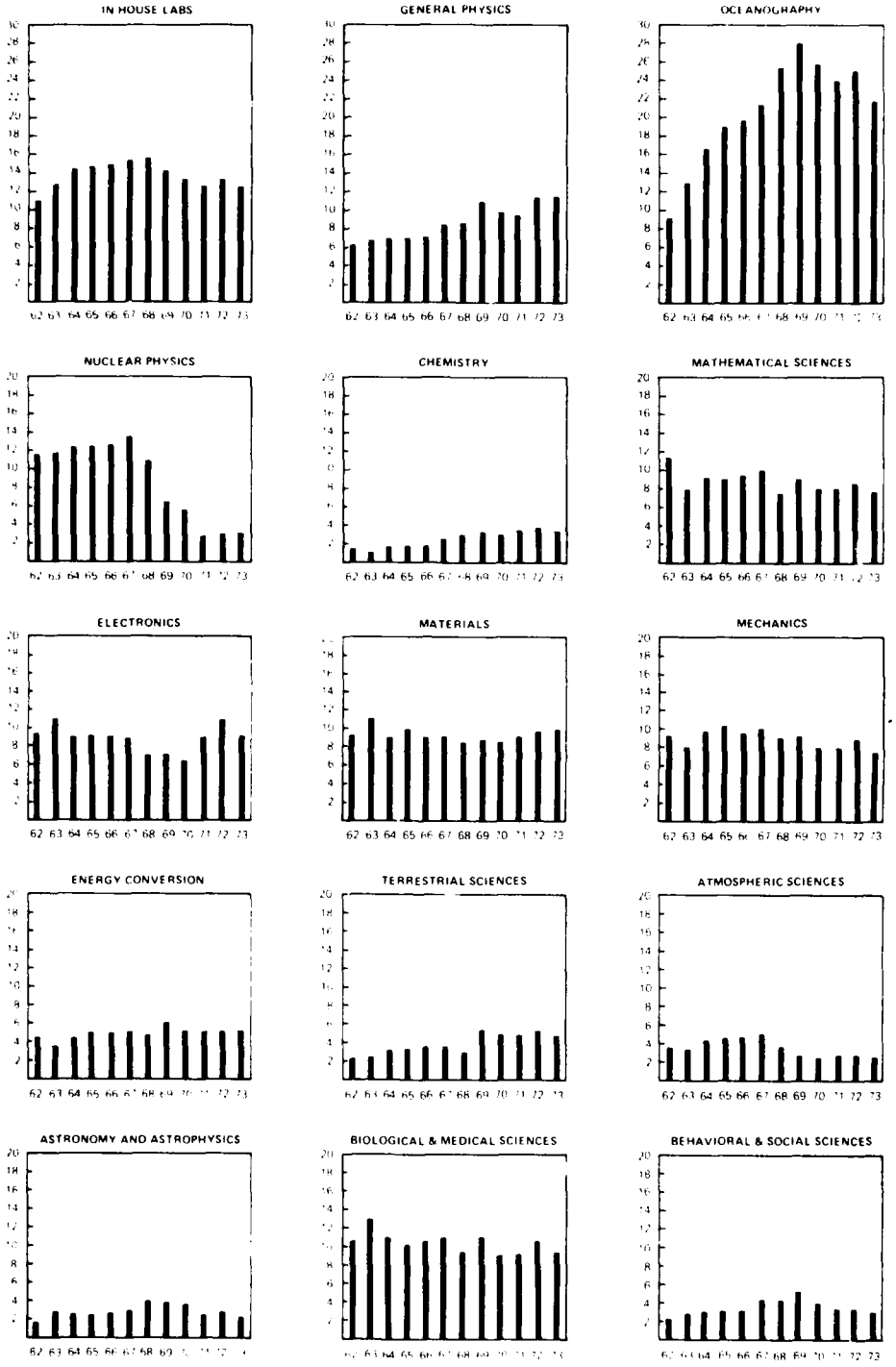


SOURCE: DATA PROVIDED BY OFFICE OF NAVAL RESEARCH.

other areas such as nuclear physics. Of course, the data presented in the exhibits do not illustrate the dynamics of the program below the subelement level, so the general question of program stability is not fully answered.

One might expect that the trend toward centralized management of defense R&D would have had an adverse impact on program stability. Both Congress and DDR&E scrutinized the program in greater detail during the last half of the era. Relevancy and possible duplication were the principal issues. Nevertheless, these reviews had a relatively minor impact on distribution of resources among scientific/engineering disciplines or program execution. Measures were, however, instituted in 1967 to strengthen the monitoring of the Naval Research program. ONR established a number of monitors, one for each of the 14 program subelements. Individual reviews were held on a regularly scheduled basis and attended by research managers from the systems commands and the laboratories.[2]

EXHIBIT V-14
Distribution of Research Funding Among Scientific/ Engineering Disciplines FY62-FY73



SOURCE: DATA PROVIDED BY OFFICE OF NAVAL RESEARCH.

Ensuring Application of Research Results

Probably of greater interest in the context of this review, which is directed primarily at management of development programs, is the problem of ensuring that applicable new knowledge finds its way into new fleet systems. Throughout the era, ONR placed great emphasis on the dissemination of technical information within the Navy and the scientific and engineering community in general. Mechanisms used for this purpose included a variety of publications (naval research reviews, journals, newsletters, reports) as well as symposia and conferences on selected topics of interest.

Despite these efforts, coupling between ONR research and bureau development programs presented a perennial problem. In contrast to the situation within the respective bureaus, where applied research and development were frequently handled by the same engineers, ONR had to "sell" their ideas to others before their application was fully tested.

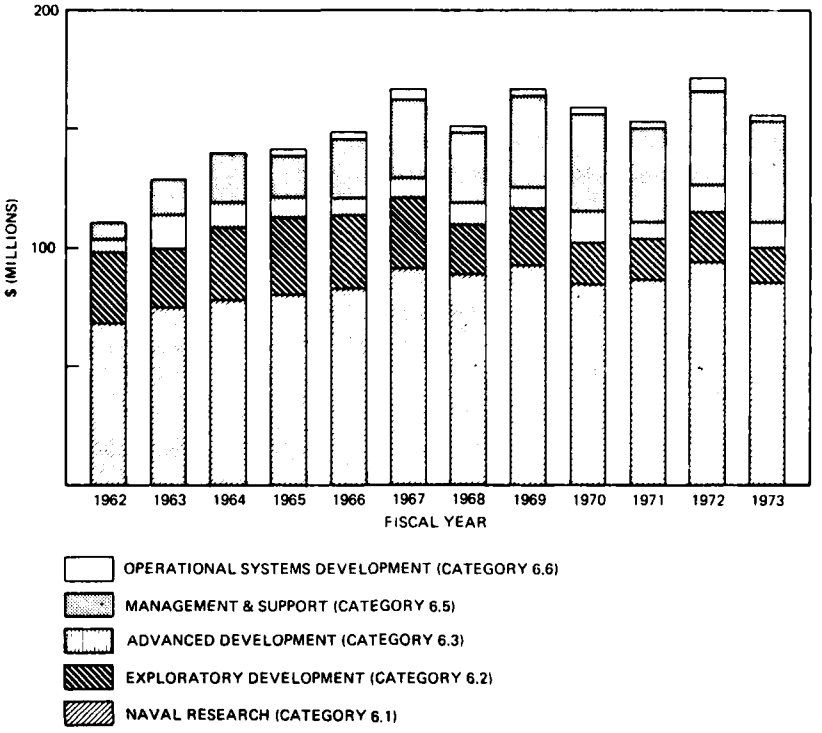
In the late 1950's, ONR established applications branches to make a deliberate effort to expedite utilization of research results. While evidence of parochialism–the "not-invented-here" syndrome–still persisted in transferring ideas from one organization to another, the application branches were able to support more follow-on effort of their own. In fact, as illustrated in Exhibit V-15 which portrays the distribution of ONR programs among RDT&E categories from 1962 to 1973, ONR became quite deeply involved from time to time, in supporting development projects. At the same time, as indicated in Exhibit V-16, the principal material bureaus and systems commands became less involved in the administration of research.

In spite of the inherent difficulties in coupling research and development across organizational lines, the track record was not without noteworthy successes. For example, Project Lamplight, sponsored by ONR in 1954, led to the initiation of the Naval Tactical Data System in 1956. In addition, early ONR work in hydrofoils found application in BuShips advanced surface craft projects. Also the cooperation between ONR and the SYSCOMS was especially effective in the field of undersea warfare systems (e.g., acoustic detection devices and the hydrodynamics of fully wetted bodies). Finally, as the list of accomplishments in Appendix E attests, there can be little doubt that much of the Navy's research found useful application.

EXPLORATORY DEVELOPMENT

While substantial effort was devoted to identifying, cataloging, and analyzing technology programs in the late 1950's, Exploratory Development did not emerge officially as a separate category until 1959. Little change was made in the way the

EXHIBIT V-15
Distribution of ONR Funding Among
RDT&E Categories FY62-FY73

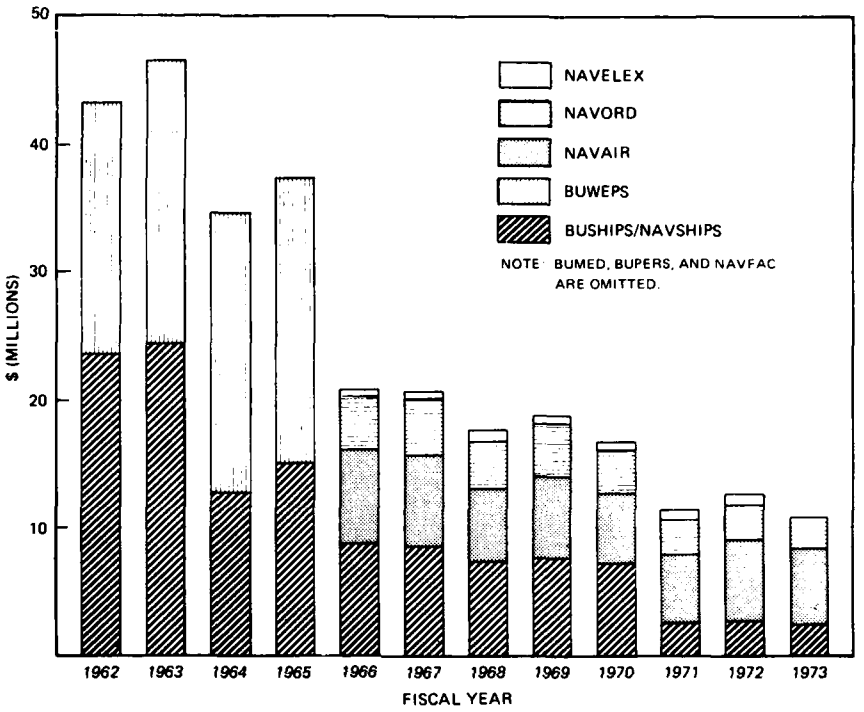


SOURCE: DATA PROVIDED BY OFFICE OF NAVAL RESEARCH.

program was executed for several years thereafter. One notable exception merits brief discussion–the increased scrutiny of Requests for Authority to Negotiate contracts under Exception 11.

When Secretary Wakelin assumed the position of ASN(R&D) in 1959, he insisted upon reviewing such requests prior to approval by ASN(I&L) who had been delegated approval responsibility by the Secretary.[3] This was to provide ASN(R&D) with an element of program control which would otherwise be lacking. In the years that followed, this review was transformed by the ASN(R&D) and CND staffs into a mechanism for control over technical and policy matters that transcended contractual considerations explicit in Exception 11. Approval was frequently hedged with certain conditions designed to ensure success of the work in question. While useful as a control device, this

EXHIBIT V-16
Bureau/Systems Command Participation in Naval Research FY62-FY73



SOURCE: DATA PROVIDED BY THE OFFICE OF NAVAL RESEARCH.

practice sometimes led to delays in executing tasks that might have been avoided if issues had been resolved in the planning stage.[4]

With this exception policies and procedures governing execution of the industrial segment of the program underwent very little change during the period. There were, however, noteworthy changes in other aspects of program execution. One of the most persistent issues from 1962 to the end of the era related to the assignment of work to the in-house laboratories. Other issues involved the persistent budgetary squeeze and the responsibility/authority for Exploratory Development in the systems commands after they were established in 1966. The paragraphs below elaborate on these topics.

The Evolution of Independent Exploratory Development

Traditionally, laboratory tasks for Exploratory Development were based on discussions between cognizant bureau engineers and their counterparts in the laboratories

concerned. Task descriptions were frequently prepared by laboratory personnel and submitted to bureaus for refinement and issuance. Funding was provided through allotments covering work to be undertaken by the respective laboratories over the course of a year. When issued, tasks cited the appropriate allotment as the source of funds.

As indicated earlier (Part II), the management of Defense R&D laboratories was subjected to intensive scrutiny in the early 1960's in response to Secretary McNamara's Question 97: "Advise me ways in which to improve the operations of the in-house laboratories." The members of the team assigned to answer this question visited many laboratories and recommended the establishment of a Laboratory Director's Fund to support work judged by the laboratory director to be promising and important with only after-the-fact review by higher authority. Despite the long-standing Navy program of Foundational Research, several laboratory Technical Directors believed they had insufficient flexibility in the internal allocation of laboratory resources to support investigation of new and innovative ideas in their early stages. A bureau sponsor first had to be "sold" on the idea, and this was not always readily accomplished. Some charged that their laboratories were being used essentially as job shops to support contracted effort rather than being given broad and challenging assignments.[5]

In 1963, the ASN(R&D) directed the bureaus to establish an Independent Exploratory Development (IED) program.[6] While most of the tasks were to continue to be assigned by the bureaus as before, work under the IED program was to be initiated by the laboratories and go forward under the Commanding Officers as a delegated responsibility of the Technical Director. IED essentially expanded the principal of Foundational Research that had evolved into a separate element, titled Independent Research (IR) and funded by ONR.

Both BuShips and BuWeps established IED programs for their laboratories in 1964.[7, 8] The policy directives issued by both bureaus indicated that the IED program was intended solely for laboratory sponsorship of advanced in-house ideas, within the framework of their assigned missions. They indicated that the principal objectives of the programs were to enhance the competence of the laboratories, permit them to grow in scientific stature, improve their ability to attract competent people, provide means for initiating challenging tasks, capitalize immediately on worthy ideas, and, ultimately, improve the capability of the laboratories for carrying out their missions. In 1965, responsibility for administering IED and IR programs at the headquarters level passed to the newly established Director of Navy Laboratories.

Through the years after its establishment, a number of attempts were made to increase the level of effort in IED. In March 1969, Dr. Frosch, Assistant Secretary of the Navy for R&D, began an effort to increase the IED program over a 5-year period to

10 percent of the Navy Category 6.2 funding. His plan was approved by a DDR&E Memorandum of March 21, 1969, but later reduced by OSD Program Change Decision. All of these attempts were subsequently rebuffed by the Armed Services Committee.[9]

The Block Funding Concept of the Mid-1960's

The development of the IED program was paralleled by a number of other attempts to extend the role of laboratories in the management of Exploratory Development. In the mid-1960's, influential members of the DDR&E staff urged the Navy to allocate 100 percent of its Exploratory Development funds in laboratory program elements, one for each laboratory. This was essentially the approach followed by the Air Force and was strongly supported by some DDR&E staff personnel.[10]

The proposal met with strong resistance from the systems commands and the CND's staff, based on the view that SYSCOM control over Exploratory Development would virtually disappear, and their ability to maintain a technology base in support of their missions would be jeopardized. Systems commands were already chafing under the decision to transfer command of laboratories to the Chief of Naval Material. They considered that their only remaining influence over program decisions in areas for which they were responsible rested with their control over resource allocations. Their argument was strengthened by the inconsistency of the DDR&E staff. While some of its members seemed to be urging virtual abdication of SYSCOM responsibilities, others, through detailed review and reporting requirements, seemed to be insisting on greater accountability.[11]

In 1968, ASN(R&D) requested CND to examine the feasibility of providing 50 percent of the Exploratory Development funds to laboratories directly from the Headquarters, Naval Material Command. After examining the potential impact of this proposed compromise, including the additional administrative and staffing changes that would be necessary, CND recommended against it and the proposal was dropped.[12]

In the meantime, urged by a series of policy directives governing laboratory assignment policies and procedures, the SYSCOMS moved to assign laboratories broader responsibilities in some Exploratory Development fields in addition to IED.[13, 14] For example, NAVAIR assigned the Naval Weapons Center, China Lake, broad responsibility for planning and executing Exploratory Development in guided missile propulsion. Similar steps were taken by the other SYSCOMS. In the early 1970's, NAVAIR also assigned deputy program management responsibilities to NWC, China Lake, NADC, Johnsville, and NAPTC, Trenton, for technology related to tactical aircraft, airborne ASW, and aircraft propulsion, respectively.

Direct Laboratory Funding

Despite the actions taken earlier, allegations that systems commands were over-managing laboratory Exploratory Development persisted. At a meeting of the Undersea Warfare R&D Planning Council at the Naval Ordnance Laboratory in 1972, Dr. Frosch discussed alternative arrangements with the Laboratory Commanders and Technical Directors present. Out of this discussion emerged a revised concept of Direct Laboratory Funding (DLF) from NAVMAT headquarters to the laboratories. DLF tasks were to encompass major, broad efforts within single functional areas in conformance with laboratory/mission functions, and lead to direct contributions within a 3-year period. Tasks were to cover efforts of $500,000 to $1,000,000 per year. Twenty-five such tasks were subsequently approved for each of the two following fiscal years, FY73 and FY74.[15]

In 1973, responding to recommendations of the Navy Inspector General, DCNM(Dev) appointed a three-man team to review the DLF Program. The team issued its report in January 1974, noting that while DLF procedure offered certain advantages in administration of laboratory funds and continuity of effort, it had disadvantages in program planning and translation of results into use. They recommended modification of the procedure whereby DLF proposals would be reviewed by SYSCOMS and funded through them when practicable.

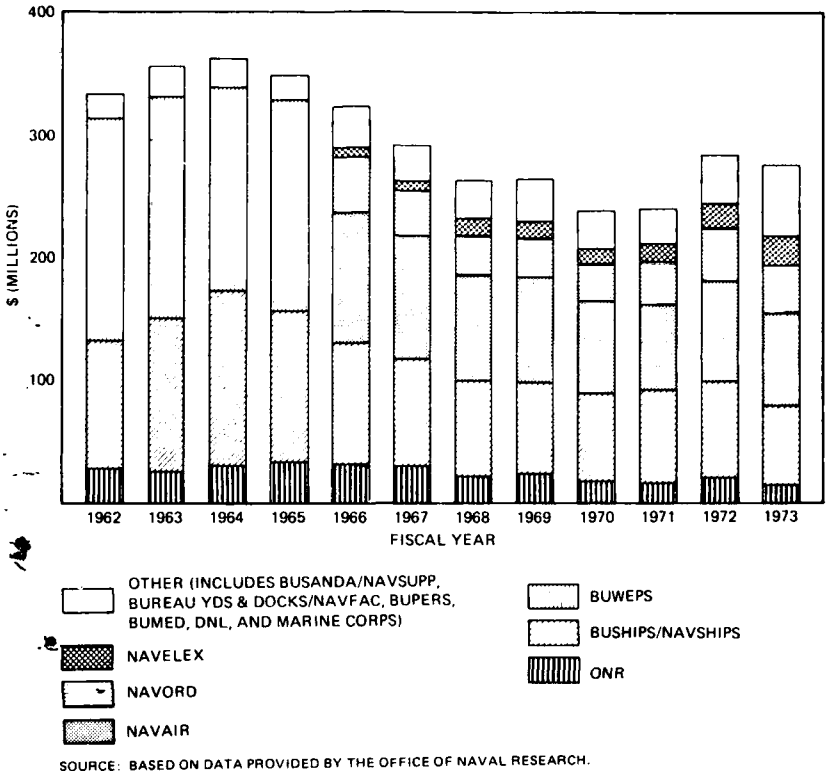
The Budget Squeeze

Exhibit V-17 depicts the trend in Navy Exploratory Development funding and distribution among bureaus and offices from FY62 through FY73.

In 1962, the Navy's Exploratory Development program consisted of approximately 162 projects subdivided into 557 task areas, most of which were composed of several tasks assigned to in-house laboratories and industry. Total program funding exceeded $332 million. In FY73, program funding was $274 million which represented a reduction in level of effort (1962 dollars) of over 45 percent. The reductions occurred mainly in the period after 1965 and were due in part to purification of Exploratory Development by transfers of effort and dollars to other categories.

Exhibit V-18 presents an overview of laboratory Exploratory Development funding during the last nine years of the era. While funding dipped briefly in the late 1960's, it ultimately returned to former dollar levels. However, the percentage of laboratory Exploratory Development funds flowing through bureaus and SYSCOMS decreased from 100 percent in FY62 to 83 percent in FY73, and this trend was exacerbated by additional CND levies for special programs in the 1970's. Finally, as indicated in Exhibit V-19, the industrial segment of the program suffered a reduction of more than 60 percent between FY65 and FY73.

EXHIBIT V-17
Distribution of Exploratory Development Funding Among Offices FY62-FY73

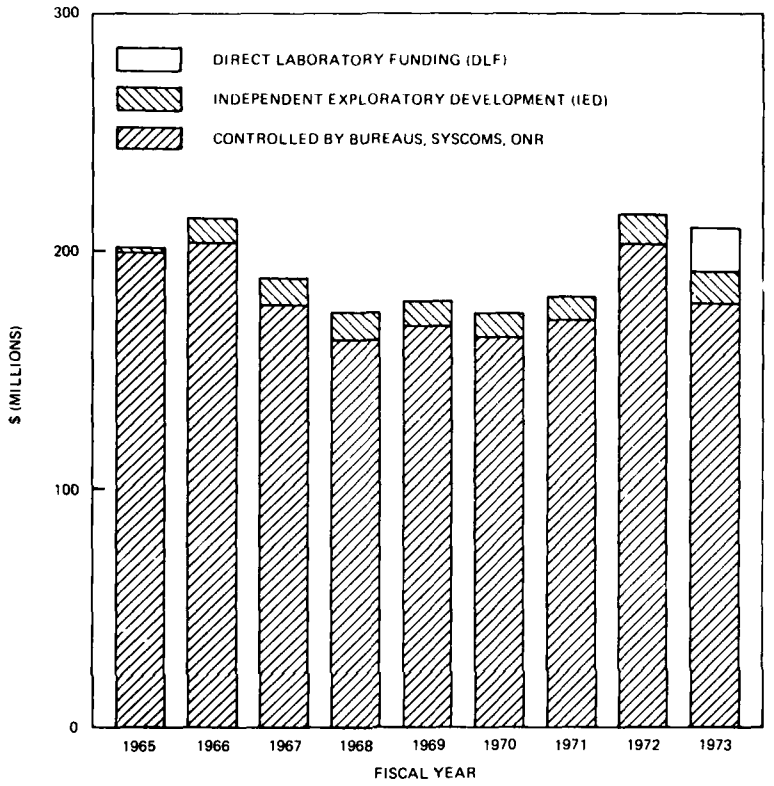


SOURCE: BASED ON DATA PROVIDED BY THE OFFICE OF NAVAL RESEARCH.

Role of the Systems Command Research and Technology Groups

As indicated earlier, responsibility for R&D in the systems commands was divided between research and technology groups/directorates and acquisition groups with the former assuming primary responsibility for Exploratory Development. In the early stages of the reorganization, the respective roles of these two groups in managing the Exploratory Development program was the subject of considerable discussion. Some believed the R&T groups should exercise broad programmatic control, leaving the administration of individual laboratory tasks and contracts to the acquisition groups. Others believed the R&T groups should be essentially self-sufficient in planning and executing Exploratory Development. During the first few years of operation, neither extreme prevailed entirely since each command adopted slightly different approaches depending on the distribution of technical expertise within the command. Subsequently, R&T groups gradually assumed increased responsibility for program execution in all of the systems commands.

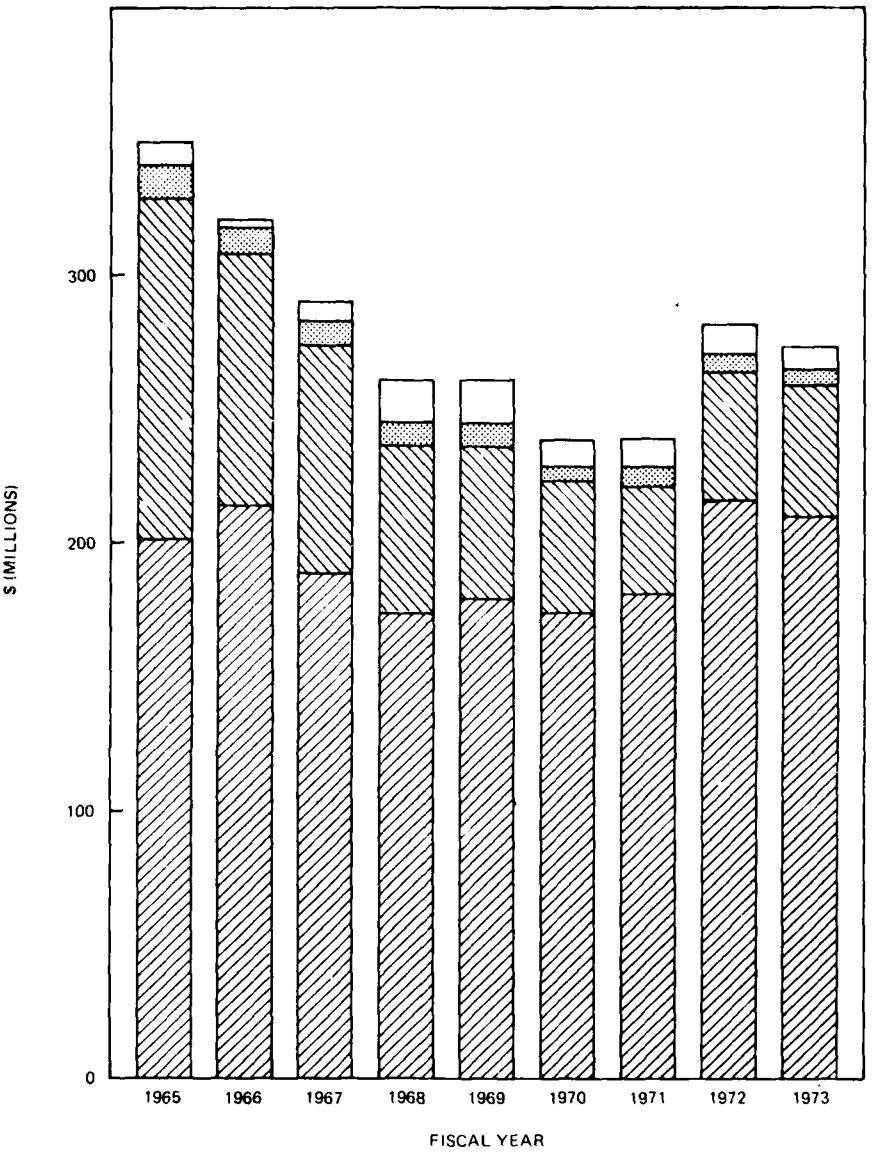
EXHIBIT V-18
Laboratory Exploratory Development Funding FY65-FY73



SOURCE: BASED ON DATA PROVIDED BY THE OFFICE OF NAVAL RESEARCH.

This trend was encouraged by the CND staff who perceived execution of Exploratory Development by the acquisition groups as inhibiting implementation of CND objectives. First, CND was trying to respond to external pressures by encouraging assignment of more meaningful program responsibilities and larger program increments to laboratories. It appeared that the program was being unnecessarily fragmented on its way to the laboratories by the intermediate technical codes. Second, CND was charged with ensuring that Exploratory Development resources were not unduly redirected to solve short-term problems. The extra layer of management represented by the acquisition groups made control more difficult.[16] In 1972, the CNM reaffirmed and strengthened his policy that management responsibility for Exploratory Development be vested in the R&T groups.[17]

EXHIBIT V-19
Distribution of Exploratory Development Funding Among Performers FY65-FY73



SOURCE: BASED ON DATA PROVIDED BY THE OFFICE OF NAVAL RESEARCH.

By the end of the era, some of the consequences of this organizational specialization were becoming apparent. No longer was coupling between technology programs and systems development automatic by virtue of continuity of participation of bureau/SYSCOM engineers. No longer did technology administrators invariably participate in the preparation of system development specifications, evaluation of proposals for new Engineering Development projects, engineering change proposals, etc. Conversely, no longer could one assume that engineers in the acquisition group were fully informed on new technological opportunities by virtue of their day-to-day participation in relevant research and technology programs.[18] Some systems commands adopted special measures to promote intergroup participation. NAVORD, for example, involved representatives of its system development groups in annual appraisals of its Exploratory Development program. NAVAIR, on the other hand, relied heavily on direct liaison between the groups based on longstanding personal relationships of the engineers involved, since many in the R&T group had served with those in the acquisition group in the old BuAer R&D organization. Some of those interviewed, however, expressed concern about the gradual erosion of these relationships as the "old hands" passed from the scene. They worried that the "fence around Exploratory Development" may have grown too high.[19]

Notes to Chapter 17

1. Department of the Navy, *Management Review of the Department of the Navy, Research and Development Management Study*, Vol. II, Study 3, (Washington, D.C., October 19, 1962), NAVEXOS P2426B-3, p. 150.

2. Chief of Naval Research, *Annual Report 1967*, (Washington, D.C., 1968).

3. Personal Interview.

4. Personal Interview.

5. Personal Interview.

6. SECNAV Instruction 3900.13A, Subject: Management of Navy Research and Development Laboratories, November 1, 1963.

7. BuShips Instruction 3920.1B, Subject: In-House Laboratory CORE Program, March 11, 1964.

8. BuWeps Instruction 3920.4, Subject: Independent Exploratory Development Program, April 20, 1964.

9. Personal Interview.

10. Personal Interview.

11. Personal Interview.

12. Personal Interview.

13. NAVMAT Instruction 3910.13, Subject: Policy and Procedures Governing Systems Command/Laboratory Management of Exploratory Development, January 30, 1968.

14. NAVMAT Instruction 3910.13A, Subject: Policy and Procedures Governing Systems Command/Laboratory Management of Exploratory Development, October 23, 1969.

15. Personal Interview.

16. Personal Interview.

17. NAVMAT NOTICE 5400, Subject: Management of Research and Technology, June 17, 1972.

18. Personal Interview.

19. Personal Interview.

SUMMARY

PRINCIPAL TRENDS IN NAVY R&D PROGRAM EXECUTION 1946-1973

Exhibit V-20 depicts significant milestones in the R&D program execution process during the era. The paucity of change from 1946 to the mid-1950's is readily apparent. The first decade was a period of relative stability during which ONR and the bureaus were free to execute programs in a fashion best suited to their respective product lines and the characteristics of the industries with which they dealt. While the approaches of the bureaus varied significantly in terms of their internal organizations, as well as their utilization of in-house laboratories and contractors, there were many similarities as well. All espoused the principle of "cradle-to-grave" engineering responsibility which encouraged continuity of purpose and accountability for results as well as close coupling between research, technology programs, and full-scale development. All recognized and accommodated the fundamental differences in management techniques applicable to these three categories of R&D effort. All delegated substantial responsibility and authority to project officers and engineers who tailored planning and control mechanisms to the needs of their respective projects.

Many of the patterns of the baseline period of the late 1940's and early 1950's persisted throughout the era. Others changed substantially under the pervasive influence of the march toward centralized control within the Department of Defense. The principal trends in program execution—and in few cases, the lack of a definitive trend—are highlighted in the sections below.

TRENDS IN NAVAL RESEARCH

The execution process for Naval Research remained relatively unchanged during the era. Reliance on the "competent individual" continued to be a prominent feature of the management philosophy. Both ONR and the bureaus/SYSCOMS still provided a high degree of freedom to the project level and below. Maintenance of in-house technical competance and utilization of the best available scientific talent remained as prime considerations in research assignments. The principle of providing discretionary funds for Foundational Research survived and evolved into a sizable program of In-house Independent Research.

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In the years that followed the baseline period, however, additional emphasis was placed on the coordination of research within the Navy Department (see Exhibit V-20). Two problems required continuing attention. One was maintenance of program stability and the proper balance in the face of budget pressures. The other was ensuring that research results found timely application in the fleet.

Between 1962 and 1973 the Naval Research program suffered over a 30 percent reduction in level of effort (dollars adjusted for the military price index). Basic research, which early in the era approximated one-third of Naval Research, had grown to about 74 percent of the program by 1973. (In this connection, it should be noted that much of the Navy's applied research had been categorized as Exploratory Development in the intervening years.) Distribution of Naval Research funding among performers (in-house laboratories, universities, and industry) changed little during the last decade of the era, and the most noteworthy change in distribution among disciplines was a marked increase in oceanography and a reduction in nuclear physics.

Throughout the era, the problem of ensuring prompt application of research results was exacerbated by organizational interfaces and the "not-invented-here" syndrome. ONR became involved in significant amounts of Exploratory and Advanced Development during the last decade while bureau and SYSCOM participation in Naval Research dwindled from over $40 million in 1962 to slightly more than $10 million in 1973. Although its impact on coupling between research and application is conjectural, the reduced participation of SYSCOMS in Naval Research provides an example of the trend toward organizational specialization in the 1960's. Despite these trends, the list of program accomplishments (Appendix E) leaves little doubt that Naval Research found useful application.

TRENDS IN TECHNOLOGY PROGRAMS

During the baseline period, technology programs represented a segment of the Navy's R&D program in which the bureaus operated with little or no outside interference. Guided only by the most general requirements, bureau personnel relied on official correspondence, discussions with OPNAV fleet and laboratory personnel, and the experience of their own officers and engineers to identify existing and projected Navy problems. Ideas for solving fleet problems and exploiting technological opportunities were converted into exploratory projects with relative ease. Project plans, task assignments, and monitoring procedures were generally flexible and tailored to the needs of the individual manager. Some projects ultimately paid off; some did not. Managers attempted to screen out the losers and put money on the potential winners.

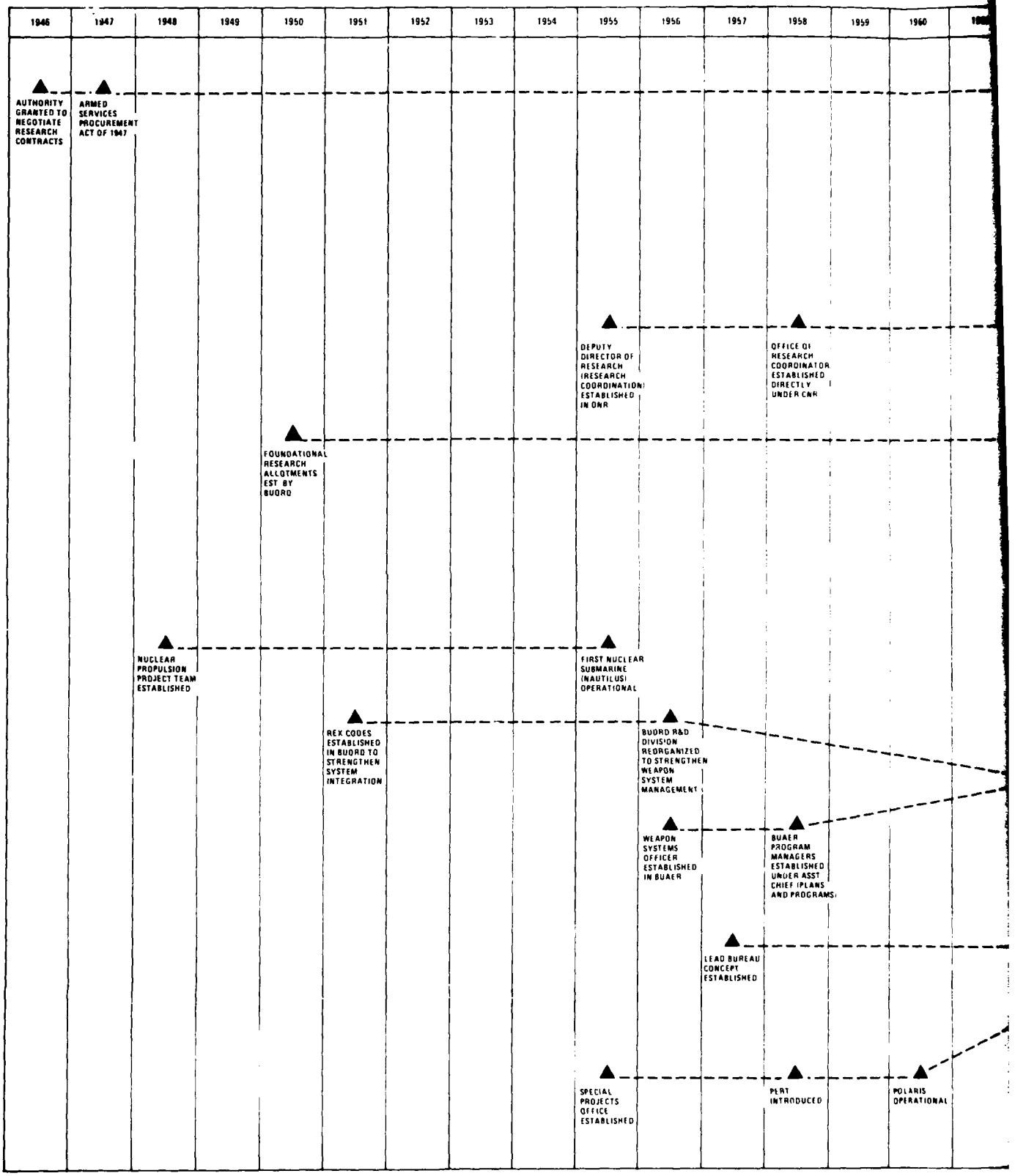
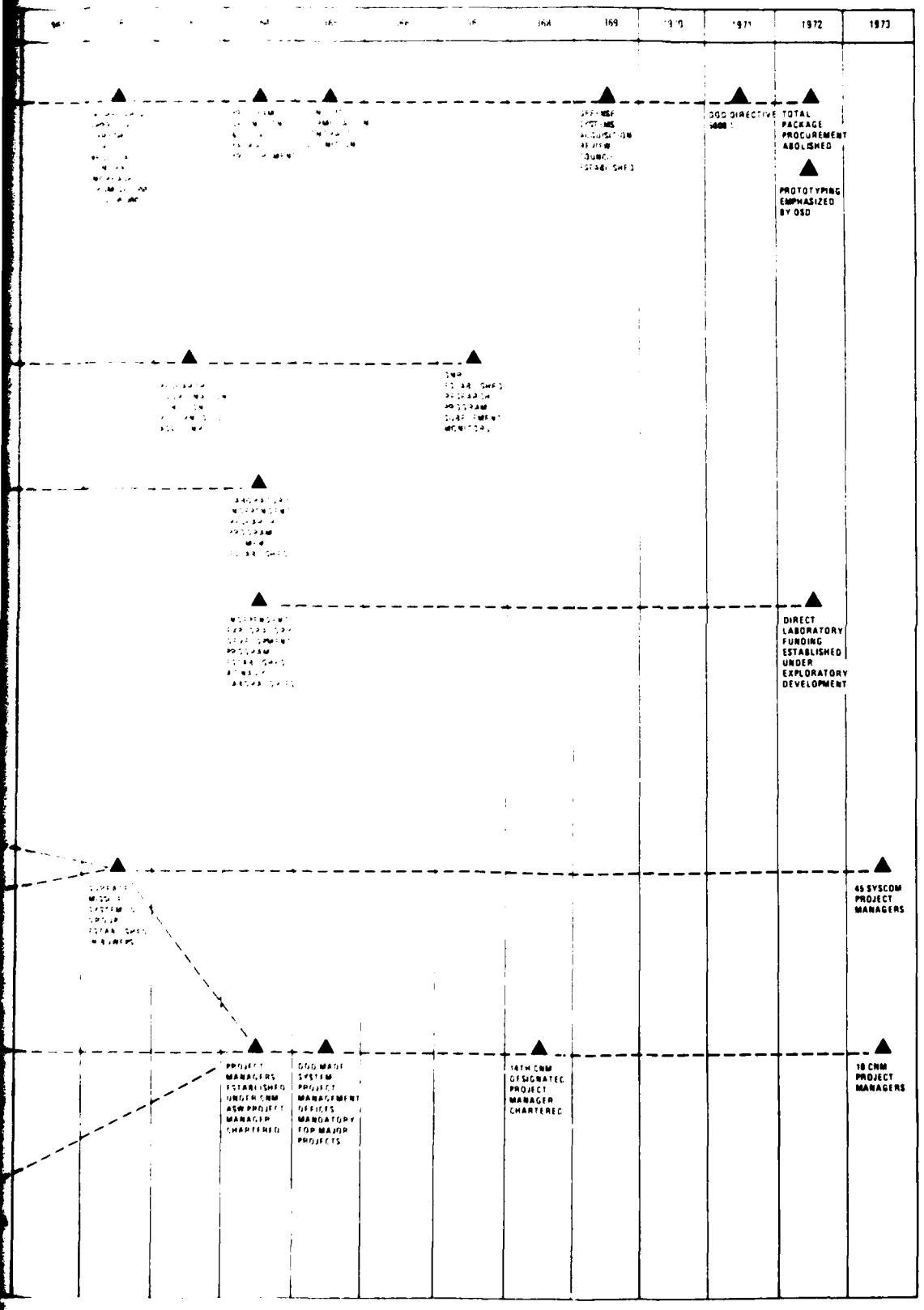

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AUTHORITY GRANTED TO NEGOTIATE RESEARCH CONTRACTS
ARMED SERVICES PROCUREMENT ACT OF 1947
DEPUTY DIRECTOR OF RESEARCH (RESEARCH COORDINATION) ESTABLISHED IN ONR
OFFICE OF RESEARCH COORDINATOR ESTABLISHED DIRECTLY UNDER CNR
FOUNDATIONAL RESEARCH ALLOTMENTS EST BY BUORD
NUCLEAR PROPULSION PROJECT TEAM ESTABLISHED
FIRST NUCLEAR SUBMARINE (NAUTILUS) OPERATIONAL
REX CODES ESTABLISHED IN BUORD TO STRENGTHEN SYSTEM INTEGRATION
BUORD R&D DIVISION REORGANIZED TO STRENGTHEN WEAPON SYSTEM MANAGEMENT
WEAPON SYSTEMS OFFICER ESTABLISHED IN BUAER
BUAER PROGRAM MANAGERS ESTABLISHED UNDER ASST CHIEF (PLANS AND PROGRAMS)
LEAD BUREAU CONCEPT ESTABLISHED
SPECIAL PROJECTS OFFICE ESTABLISHED
PERT INTRODUCED
POLARIS OPERATIONAL

EXHIBIT V-20

Significant Milestones for R&D Program Execution 1946-1973



In the years that followed, some features of this pattern survived. Others were radically altered by the dual trends toward program compartmentalization and organization specialization stemming from the creation of separate categories for Exploratory and Advanced Development.

Of the two categories, program execution procedures changed the least in Exploratory Development. Despite the disruptive effect of multiple staff reviews and occasional fund deferrals, the DDR&E level of effort control philosophy for this category preserved a modicum of freedom for those responsible for program execution. They were, however, clearly affected by the budget squeeze through which the level of effort in the category was reduced more than 45 percent.

From the bureau/SYSCOM point of view, the problem was compounded by the trend toward greater independence of Navy laboratories and the concomitant increase in discretionary funding (IED and DLF) indicated in the milestone chart. They vigorously opposed the block funding proposal of the mid-1960's on the grounds that it amounted to delegating authority to the laboratories without commensurate accountability for fulfilling SYSCOM responsibilities.

While the Exploratory Development program diminished, the Advanced Development category, composed of projects subject to higher level control, grew more than tenfold in total funding and number of projects. Increased emphasis on planning of these projects was accompanied by more intense monitoring by both OPNAV and DDR&E. The trend was perpetuated by Concept Formulation procedures which focused primarily on Advanced Development.

During the baseline period, coupling between technology programs and full-scale development had been virtually automatic. This was attributed by those interviewed to the "cradle-to-grave" engineering responsibility inherent in the bureau management philosophy. In the 1960's, this had largely been abrogated by program compartmentalization and organizational specialization.

REALIGNMENT OF SYSTEM PROJECT MANAGEMENT RESPONSIBILITY AND AUTHORITY

The realignment of system project management responsibility and authority was one of the most prominent trends of the era.

During the baseline period, much of the bureau's development effort focused on components and subsystems that were ultimately procured separately and furnished as government-furnished equipment for installation in ships or aircraft. System integration consisted largely of fitting the various pieces together within the physical envelope of an

airframe or hull. By the early 1950's, important influences were at work on this traditional pattern of program execution. The pace of technological development presented opportunities for quantum advances in defense systems, and pressures mounted to shorten development and production leadtimes. Responses to these pressures hinged on the ability to achieve close coordination of concurrent development of critical subsystems and components which led in turn to a number of organizational changes indicated in the lower portion of the milestone chart. Thereafter, spurred by a 1965 OSD policy directive, special offices for project management were rapidly superimposed over the traditional bureau functional engineering organizations.

In emphasizing the designated project manager approach, the intent was clearly to fix responsibility at the project level and hold managers accountable for results. Despite declarations of broadly delegated authority, however, regulation of program execution through standard procedures reached unprecedented levels in the 1960's as uniformity of approach became the hallmark of centralized management. Total Package Procurement and Contract Definition were the most prominent of the techniques imposed by OSD in the 1960's. Less visible, but fully as pervasive in their impact, were the numerous directives governing requirements for reliability, maintainability, value engineering, etc., which in earlier times had been delegated to the project level under the heading of "sound engineering practices." Each of these "ilities" had to be reflected in project plans for the review of staff specialists, and a variety of special plans had to be prepared and maintained in response to requirements of various functional groups. The 1972 edition of the Navy RDT&E Management Guide listed 137 official directives and manuals related to R&D management, all of which were issued by organizational levels above the systems commands. This contrasted sharply with the situation at the start of the era when few such directives existed.

The growth in the corporate structure, staffing of project management offices, and increased demands of higher authority for project information all placed substantial stresses on the personnel ceilings of the development agencies. Toward the end of the era, project managers and their staffs were spending at least as much time defending their proposed approach and decisions to higher authority as they spent directing the projects for which they were responsible. SYSCOM personnel, previously devoted to technical/engineering functions, became increasingly involved in general management functions (e.g., planning and financial control). Interviews revealed a broad consensus that technical expertise at the SYSCOM level had eroded substantially and that headquarters was much more dependent on industry and laboratories and less capable of making independent technical judgments.

INDUSTRY AND IN-HOUSE LABORATORIES

Changing patterns in the utilization of industry were closely related to the trends at headquarters. Traditionally, the Navy had maintained close partnership with industry based on contracts judged to be equitable by the parties concerned in view of the inherent uncertainties in the R&D process. In the mid-1950's, industry generally began to assume additional responsibility for system integration. The trend was toward higher dollar-value prime contracts and was accompanied by demands for increased accountability for total system performance, more stringent contract forms, etc., all of which tended to increase the risk to the contractors involved. The fundamental uncertainties of R&D were sometimes ignored to the detriment of contractors as well as the government. Changes induced by technical and funding exigencies or reexamination of decisions through multiple staff reviews became more difficult to accommodate. Contractor performance evaluations, cost information reporting, and increased demands for studies, analyses, and other technical data were further evidence of emphasis on management.

The in-house laboratories were also affected. Not only was there a greater market for their analytical services but project managers turned to them for more and more administrative support. On the other hand, attempts to encourage assignment of broad project management authority to laboratories were inconclusive. This may or may not have been influenced by an emerging spirit of competition between laboratories and industry. Some laboratory Technical Directors interviewed clearly believed that their organizations should perform the bulk of the research and innovative development work, with industry providing the production base. Needless to say, this view was by no means shared by their counterparts in industry. This incipient conflict further complicated the policy issues surrounding the utilization of laboratories in managing system development projects.

SYSTEM DEVELOPMENT COSTS AND LEADTIMES

The literature of the era is replete with expressions of concern over trends in development cost and leadtime. Persons interviewed cited instances early in the era where projects were accomplished in "record time" which they believed could not be equalled in the centralized management environment that prevailed later in the era. Others cited examples of disruptions in project schedules by protracted staff reviews and last-minute budget changes.

Clearly the costs of development rose dramatically along with system complexity. Based on interviews, it is also reasonable to assume that increased administrative red tape not only complicated the planning process but also contributed to delays (and probably cost escalation) in program execution. Attempts to quantify its impact, however, proved inconclusive. While a correlation of leadtimes, costs, and other measures of R&D

management effectiveness with causative factors such as changes in headquarters policies and procedures may be achievable in the future by virtue of improved recordkeeping, it proved impractical as a part of this Review. The complexities and uncertainties inherent in such an analysis were apparent from an examination of the few project records and case studies that were readily available. First, the starting dates of projects were not always comparable. Project initiation in the 1940's, for example, frequently represented the start of laboratory feasibility investigations rather than full-scale development. In fact, it was difficult to identify in some cases when full-scale development, as the term was later applied, actually commenced. Second, any analysis of development leadtimes could be misleading unless the reasons for delays were examined in some detail. Variations in technical complexity of projects, unforeseen technical difficulties, revisions to requirements, and funding exigencies were but a few of the factors influencing costs and leadtimes. Third, the personalities and management styles of individuals involved apparently had a decisive impact on the execution process. In summary, the unique features of projects seemed to outnumber the similarities–departure from the norm appeared to be the rule rather than the exception.

SYSTEM PROJECT MORTALITY

Project mortality rate–successes versus failures–is sometimes cited as a measure of R&D management effectiveness. In this context, over 231 aircraft, weapons, and other major systems/subsystems projects were initiated and concluded during the era (see Appendix D).* Of these, 205 were successfully completed in the sense that their end products were accepted and used in the fleet; the remaining 26 were cancelled.

A comparison of "successful projects" versus cancellations may be misleading, however. For one thing, a cancellation did not necessarily imply a failure in executing the projects in question. Some projects were cancelled as a result of funding decisions involving higher priority endeavors, while others were continued in the face of escalating costs and technical difficulties because of the high priority of their requirement.

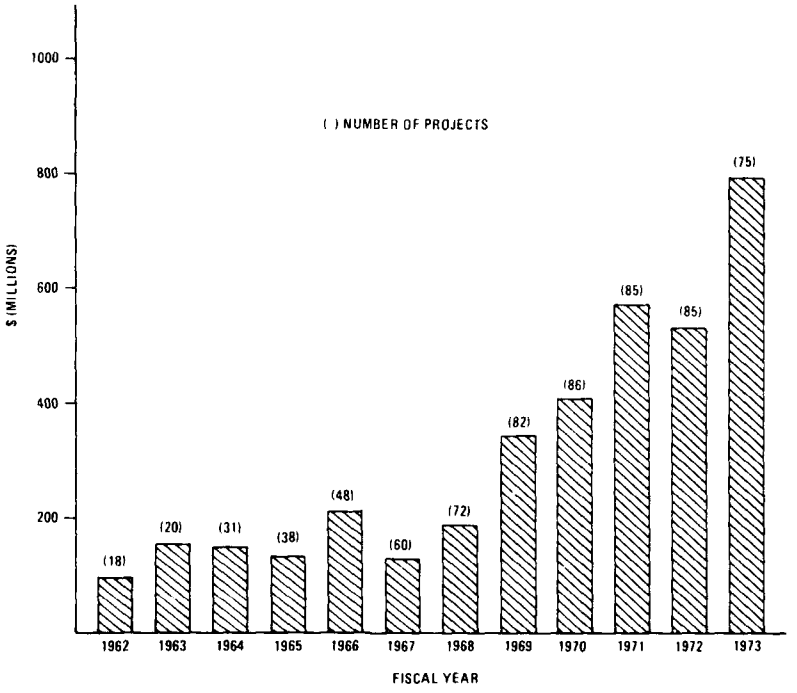
Despite these uncertainties, there does appear to have been a marked decrease in the number of major project cancellations during the 1960's compared to the 1950's–possibly due to more stringent control over initiation of full-scale development as the era progressed. For example, the number of new aircraft starts decreased substantially as a function of time (Exhibit V-21). A similar trend is discernible in the field of guided missiles. In this connection, however, it should be noted that a number of missile projects existing in the 1940's and early 1950's would probably have been considered as exploratory or advanced development efforts in the 1960's. Finally, it would be erroneous to conclude that the number of new starts in all fields of R&D decreased in a similar fashion. In fact, the number of engineering development projects increased during the 1960's (Exhibit V-22).

* Does not include numerous modifications or successive models of basic systems many of which were highly significant.

EXHIBIT V-21
Number of New Aircraft Starts in Navy Program 1946-1973

Seven-Year Period	Number of New Starts
1946 - 1952	35
1953 - 1959	19
1960 - 1966	10
1967 - 1973	7

EXHIBIT V-22
Engineering Development Projects 1962-1973



COMMENTARY

Throughout this review, the disruption of traditional lines of responsibility and authority, the layering of staffs, the proliferation of procedures and controls, and the apparent insatiable demand of higher levels for program information were often cited as adverse trends. Those interviewed frequently contrasted the situation at the end of the era with the emphasis on delegation and trust in subordinates that prevailed earlier. While nostalgia may have been a factor in some of these comments, there can be little doubt that the Navy Department in 1946, whose lines of communications were short and direct, contrasted sharply with the extensive corporate structure that later developed.

Early in the era the Navy R&D community was a close-knit group in which the professional reputations of its members were well known by the senior officials in the Navy Department. They relied heavily on the "competent individual." As the corporate structure matured, new executives appeared both in the Navy Department and the Office of the Secretary of Defense–some for relatively short periods of time–who were not as familiar with the Navy, its people, and its traditional patterns of responsibility and authority. In some cases the resulting infusion of new ideas was beneficial. In some cases it was also highly disruptive. But there developed a general propensity for regulating performance through procedures and management systems. Sapolsky noted this pattern in his book on Polaris when he stated:

> For programs that consume enormous amounts of resources and are subject to external review, the pressure to develop management techniques that warn early of operational weaknesses and that control deviations from established goals is considerable. The management of any large-scale organization. . . thus always has an interest in discovering new mechanisms to relieve their anxiety about the behavior of organizational participants. . .*

Despite the feeling that sound management principles had on occasion been seriously compromised, interviewees acknowledged that the changes in R&D management during the era were sincerely motivated–frequently necessitated by the revolutionary increase in technical complexity of defense systems and the financial risks their development entailed. They were also quick to point to the record of accomplishment in Navy R&D. Supersonic aircraft, nuclear propulsion, fleet ballistic missiles, and tactical data systems (to name a few) all came of age during the era. Over 205 systems had been started and successfully completed. Many of these systems had been developed through the extraordinary skills, dedication, and perseverance of individuals in headquarters, in-house laboratories, and industry. Many found useful application in wartime not only in the Navy but in the other Services. In the final analysis, this record of achievement is the bottomline for Navy R&D management.

* Harvey M. Sapolsky, *The Polaris System Development*, Harvard University Press, Cambridge, Mass., 1972, p. 95.

APPENDIX A

SELECTED MATERIAL ON NAVY R&D LABORATORIES

Appendix A includes two documents pertinent to Navy R&D Laboratories. The first is the Navy Department response to the Sherwin Plan enclosed with a covering memorandum from Dr. Robert W. Morse, Assistant Secretary of the Navy (Research and Development) to the Secretary of the Navy. The second document comprises detailed Navy Department comments on and possible solutions for the 42 "current" problems in the defense in-house laboratories in 1966.

THE ASSISTANT SECRETARY OF THE NAVY
(Research and Development)
Washington, D.C. 20350

4 January 1965

MEMORANDUM FOR THE SECRETARY OF THE NAVY

Subj: Management of Navy Laboratories

Ref: (a) A Plan for the Operation and Management of the Principal DOD In-House Laboratories, dated 16 November 1964

(b) DDR&E memo to SECNAV, Management of DOD In-House Laboratories, dated 25 November 1964

Encl: (1) On the Management of Navy Laboratories

Reference (a) forwarded a proposed plan for the management of DOD laboratories on which the three services were asked to comment. In reference (b) it was emphasized that the proposed plan was intended to stimulate our consideration of the questions raised and we were invited to suggest modifications or alternatives in light of problems peculiar to the Navy. Subsequently it was agreed that we would submit an interim response to reference (a) by 8 January 1965 and indicate what new steps we proposed to take toward the objective of improving laboratories.

Enclosure (1) is a brief report prepared for your consideration. In this I consider the relevance to the Navy of the OSD proposal and list some immediate new steps which, subject to your concurrence, I plan to take. These steps are consistent with many of the recommendations of the OSD proposal and if vigorously pursued could increase the effectiveness of our laboratories considerably.

By far the most significant of these steps is the establishment of a civilian Director of Navy Laboratories. He would report to me in parallel with the Chief of Naval Research and the Chief of Naval Development, and indeed would work very closely with both of them. I would expect him to be responsible, not only for the uniform implementation of laboratory policy matters, but also for many specific questions related to the selection of senior civilian personnel, facilities development, and program planning. Most importantly, his office would provide needed high-level departmental attention to laboratories.

I wish to emphasize, however, that I cannot support the proposal that our principal laboratories be separated organizationally from the Bureaus. As indicated in enclosure (1), this move in the long run could only isolate the laboratories from the mainstream of R&D decisions, and make them less effective in support of the total technical effort.

It seems to me that the basic laboratory problem is contained in the following statement: Laboratories, to be effective, must be centrally placed in the Navy; yet, laboratories, to be good, must be given special management attention.

The OSD proposal achieves the required management attention by separating laboratories in essential ways from the rest of the Navy. Even if I thought this would make dramatic and immediate improvements in the internal health of the laboratories (which I do not), the price in effectiveness would be too great. I want to see the Navy laboratories, as our basic source of technical ideas, talent, and judgment, have a greater impact on the whole research and development process. This possibility could only be significantly lessened by making them organizationally independent.

Nevertheless, laboratories do require special management attention if they are not to be overwhelmed in a large organization. And the evidence is clear that laboratories find it hard to get the timely and flexible control over facilities, personnel, funds and supporting activities which their special functions demand. Such problems must be attacked not only within the Navy but in a general way within the DOD. Therefore, I intend to examine these questions in the Navy, and in concert with OSD.

Finally, I would emphasize that there is really much more involved in the issues raised here than laboratories. As time goes on, the increasing pace of technical change and subsequent complexity (and cost) of weapons systems is placing more and more strain on the limited technical and financial resources of the Navy. This trend requires not only more imagination and skill in technical innovation, but also a more expert discrimination and discipline in weapons-systems developments than in the past. It is essential, therefore, that we make every effort to raise the level of excellence of all our technical resources and insure that we make the necessary use of them.

Any fundamental attempt to improve the effectiveness of laboratories, therefore, must be part of a general effort to improve the effectiveness of the Navy's total research and development enterprise. Thus, there are

many other questions which deserve equivalent and simultaneous attention: The Role of OPNAV in R&D, the role of the various Special Projects offices, the technical resources of the Bureaus, the problems of contract R&D operations, etc. Such questions have not been addressed in my response, but I have every intention of examining them in detail in the immediate future.

/s/ ROBERT W. MORSE

ON THE MANAGEMENT OF NAVY LABORATORIES

4 January 1965

Reference: (a) "A Plan for the Operation and Management of the Principal DOD In-House Laboratories" dated 16 November 1964

(b) DDR&E Memo to SECNAV, "Management of DOD In-House Laboratories dated 25 November 1964

Introduction

Reference (a) outlines a number of proposals aimed at improving the effectiveness of DOD laboratories. The present report is the Navy's interim response to this plan. In this document, important points of agreement or disagreement with reference (a) will be indicated and plans for further action will be given.

It should be noted that there are signficant organizational differences among the three Services as noted in reference (b); thus, this document interprets reference (a) only in terms of its particular applicability to the Navy.

This report was made not only in the light of the experience of the Office of the Assistant Secretary of the Navy for Research and Development and his principal advisers, but also after the consideration of detailed comments from all senior personnel concerned with R&D and laboratory matters, including all Technical Directors and Commanding Officers. In addition, at the request of the Assistant Secretary of the Navy for Research and Development, five special studies were made by task groups of experienced civilian and military personnel in order to provide detailed and up-to-date background on some of the major issues. Finally, these results and reference (a) were discussed at length by a group consisting of the ASN (R&D), his principal advisers (CNR, CND, and DCNO(D)), and three of the most senior civilian scientists in the Navy.

ENCLOSURE (1)

In preparing this response, therefore, a great many relevant opinions and judgments were solicited and considered. However, the statements in this report represent entirely the conclusions of the Assistant Secretary of the Navy for Research and Development.

Background

The present complex of the Navy's in-house RDT&E establishments employs over 9,000 scientists and engineers. This complex represents an investment of about one billion dollars in land and buildings, and the annual workload is about 550 million dollars. Because of the great breadth of the Navy's military role, this complex performs a wide variety of essential tasks and missions ranging from basic research to the support of specialized equipment in the fleet.

The basic purpose of the Navy's laboratories is to provide the present and future fleet with the most effective weapons and equipment possible.* To fulfill this purpose well, the laboratories, not only must be producers of science and technology, but they also must be thoroughly alert to the present and future problems of the fleet. As principal sources of technical knowledge and ideas within the Navy, the laboratories must be places where good science is done. But this is not sufficient. To be effective, the laboratories must also be able to translate technology into military reality, and to do this two conditions are necessary: first, the laboratories must be in immediate contact with the operating problems of fleet equipment; and, second, the laboratories must be so placed and so used that they have an important voice in systems decisions and planning.

Over the years, the Navy has succeeded in building up laboratories of high quality and demonstrable effectiveness. Moreover, the Navy has been fortunate in recruiting and retaining within these laboratories many first-rate scientists and engineers who have developed great knowledge and understanding of naval problems. The best of these laboratories not only have been involved in fundamental scientific or developmental research, but they have also had intimate contact

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* Although this is the purpose of the laboratories, they are not the only organizations supporting this objective. In fact, it is the purpose of the whole R&D organization.

with the operating Navy. In trying out new ideas, laboratory scientists have ridden operating ships, submarines, aircraft side-by-side with naval officers. Many of the ideas followed up in these laboratories which later led to operating weapons or equipment were inspired by such contact and were made practical by such experience. Examples of this are manifold: the successful conventional weapons developed at NOTS China Lake; the NTDS at NEL; and the LULU, BETTY, and HOTPOINT weapons at NOL.

The basic question, therefore, is not "How can the Navy's laboratories be made effective?" It is rather the relative one—"How can they be made more effective?"

Any approach to answering this question must recognize that there have been many steps taken in recent years to improve the effectiveness of laboratories. The following actions are examples of measures adopted in recent years:

Establishment of the Laboratory Management Committee under a special assistant to ASN (R&D) to oversee the implementation of SECNAVINST 3900.13A.

Establishment of focal offices for laboratory affairs in the several Bureaus.

Clarification of the relative roles of the Commanding Officer and Technical Director.

Establishment of the Chief of Naval Development, reporting directly to ASN (R&D), with direction and management authority over exploratory development, including funds.

Increase in the discretionary funds of the laboratory directors.

Introduction of independent exploratory development funds for laboratories.

Institution of annually updated five-year research and development plans prepared by the laboratories.

Establishment of the Navy Senior Scientists' Council to provide a means of cooperative effort on matters of common interest to the Navy laboratories.

Indeed, a review shows that of 50 recommendations from four reports made in the past ten years concerning laboratories, the Navy has implemented 32 fully and 13 partially. This record, although it does not imply that the objectives of the recommendations have been fully reached, does suggest a serious and continuing awareness of the importance of laboratories.

In general, past efforts have tended consistently in certain directions which have been acknowledged to be essential. For example, there has been a recognition that laboratories must have more responsibility in the determination of their own programs and that the Technical Director must have clear authority over the main function of the laboratory—the technical program. Also, there has been more widespread recognition that running a laboratory is qualitatively different from running a production facility such as a shipyard. Thus, there have been policies designed to give laboratories the uniform and sympathetic treatment which their special functions require.*

Such goals, however, have not been fully reached. In some cases not enough time has elapsed for the effects of actions to become observable; this is the case, for example, with the independent exploratory development funds, five-year planning, and the efforts of the Chief of Naval Development to coordinate exploratory development. In other cases the basic difficulties have proved extremely intractable. This is true particularly in the areas of facilities (construction and maintenance), personnel, financial management, and details of program funding. The unresponsiveness of the total organization to the peculiar needs of laboratories has been emphasized many times (Dillon Report, Task 97, etc.). But the sources of most of the policies

* For example, SECNAVINST 3900.13A sets forth policies and procedures for the management and operation of Navy research and development laboratories, making it clear that the organization of the laboratory and its relations with the management agency and other agencies shall be such as to promote the prime function of the laboratory, the conduct of research and development.

governing these areas are outside the RDT&E chain, and it has been difficult to secure the special attention essential for laboratories.

Therefore, any comprehensive plan to increase the vitality and effectiveness of Navy laboratories must recognize that changes cannot be done in isolation from the complex environment in which these laboratories must function. The need and the conditions for laboratory vitality must have widespread understanding and there must be consistent cooperation throughout, not only the Navy, but OSD and the Federal Government as well.

Specific Comments on the OSD Proposal

Reference (a) suggests a number of proposed changes for improving DOD laboratories. Some of these are logical extensions of policies long promoted by the Navy; others represent either new steps or radical departures from past philosophies. In this section, elements of the proposed changes will be discussed and judged in terms of their particular merit with respect to the Navy.

Reference (a) makes many observations and suggestions with which the Navy concurs. The most important of these are:

a. That laboratories need special management attention.

b. That there is a need for a greater degree of self-generated programs (i.e., "core" programs).

c. That laboratories are burdened with an excess of red tape and outside supervision.

d. That the principal laboratories should be "broad spectrum;" i.e., their concern should extend from basic science through systems.

e. That laboratories must be involved in systems innovation if they are to contribute effectively to the development of systems.

f. That there should be a department-wide focus for laboratory affairs, such as could be obtained with a Director of Navy Laboratories reporting to ASN (R&D). This point will be discussed subsequently.

These suggestions or observations, as the case may be, point toward several essential objectives: the delegation of more authority and responsibility to the laboratories; the protection of the long-term productivity of the laboratory from short-term fluctuations; an unimpeded feed-back loop from systems in use to exploratory development, at the local laboratory level; and continuing high-level and authoritative attention to laboratories to insure their overall vitality and long-range development.

On the other hand, reference (a) makes certain organizational proposals with which the Navy has fundamental disagreement. Although these measures may appear to provide certain immediate benefits, they would not in the long run lead to more effective laboratories or a more effective R&D establishment for the Navy. These proposals are:

a. That there should be an "organizational barrier" between research, exploratory development, and advanced development on one hand and systems developments on the other.

b. That the principal laboratories should be organizationally separate from the "Weapons Systems Development Organization" (in the Navy, this is NMSE and its Bureaus, although these have broader materiel functions in addition to development) and that this should be a civilian "line" organization reporting to the Assistant Secretary for Research and Development through a Director of Navy Laboratories.

c. That the contract program for basic research should be removed from the Office of Naval Research and transferred to the Director of Navy Laboratories.

One of the greatest needs at the present time is to bring greater technical discrimination and judgment to bear at the time of the initiation of systems development. Indeed, one of the most desirable goals is to give the laboratories a greater technical voice in weapons-system decisions and follow-through. To produce organizational barriers at this crucial transition point, and to separate the laboratories from the organizations where these decisions are made, not only would tend to isolate the laboratories from the main stream of development concerns, but it would also isolate the Bureaus from their primary technical resources. In time the laboratories would tend to develop the same relationships with the Bureaus that private or industrial organizations

have. In fact, the Bureaus would have less responsibility for laboratories than they have for contract operations for which they must provide complete funding.

It should be observed, too, that the Assistant Secretary of the Navy for Research and Development has responsibility for the whole RDT&E process. The proposed organizational change would lead to two independent technical chains separately reporting to him; both of these chains, however, would have similar and overlapping concerns in the R&D process. In order to have major responsibilities in the making of technical decisions, laboratories should be responsible partners at that level of organization where these decisions are primarily, properly, and most frequently made; i.e., at the Bureau level.

The OSD proposal, further, makes a significant issue of a differentiation between the roles of civilian and military personnel in laboratory management. In essence it proposes that the principal laboratories be managed exclusively in a civilian chain reporting to the ASN (R&D), whereas military officers would manage the Bureau R&D chain. With respect to the Navy, this move would be unfortunate. This step could only accentuate the separation between the principal laboratories and the Bureaus—which would still have major development responsibilities. Not only would there be an organizational barrier through the center of the development organization but this would be a civilian-military cleavage as well.

The proposal also overlooks the fact that the partnership between the Commanding Officer and Technical Director which has evolved in the Navy can benefit the R&D process. Furthermore, problems of conflict or in-expert interference can be avoided by choosing the right officers for such assignments and by placing the responsibility for the technical program squarely with the Technical Director.

Finally, the OSD proposal suggests that the research funds presently administered by the Office of Naval Research be transferred to the Director of Laboratories. No specific reasons are advanced for this, however. In view of the extremely well-managed program of research which ONR has sponsored for many years, there seems to be no justification for this change.

Objectives and Plans

It is felt that the OSD proposal properly identifies certain of the problems which inhibit the full effectiveness of laboratories in the R&D organization, and that it makes certain proposals which could be of benefit to the Navy. In particular, it recognizes the fact that in a large organization laboratories require special management attention. However, it is felt that the organizational solution proposed is fundamentally incorrect in that it provides this special attention by essentially isolating the laboratories from the rest of the establishment.

These suggestions, however, do not imply that the Navy should not or cannot take significant steps to improve the effectiveness of laboratories. But such steps must address two problems simultaneously: that of increasing the technical competence and the vitality within the laboratories, and that of making the laboratories have an increasingly responsible role in weapons systems decisions, planning, and follow-through.

Our examination of the situation has made it clear that satisfying a relatively small number of fundamental objectives will allow the Navy to take much better advantage of the laboratories' potential contribution to the technical effort. Thus, the steps for strengthening the Navy's laboratories must have the following interrelated purposes:

a. To increase delegation of authority and responsibility to the laboratory level.

b. To give laboratories more voice in overall R&D planning and systems decisions.

c. To increase the active systems involvement of laboratories—from conception, to experiment, to use, and follow-through.

d. To increase the climate in the laboratory for scientific and technical vitality and supply more "elbow-room" for the pursuit of ideas generated there.

e. To minimize traumatic fluctuations in funding or programs so that coherence of effort within the laboratory can be maintained.

f. To give increased attention to overall policy and planning affecting laboratory matters.

In view of these objectives and the considerations previously outlined in this report, the Assistant Secretary of the Navy for Research and Development is initiating the following actions:

a. Establish a new position of Director of Navy Laboratories (DNL). This is to be a civilian post, reporting directly to the ASN(R&D) and coequal with the Chief of Naval Research and the Chief of Naval Development. The purpose of the DNL will be to provide department-wide attention to the optimum development and use of the Navy's laboratory resources. Thus, he will have the responsibility in such matters as the selection of key civilian personnel, long-range planning for the activities of the laboratory complex and for its facilities, and the assurance that the laboratories have what special status they require to be effective.

b. Take steps to see that the budget structure and the programming procedures are modified and meshed with present procedures to provide "block" funding of sufficient magnitude to provide laboratories with both improved funding flexibility and greater independently planned exploratory development effort.

c. Examine present policies and practices, both within the Navy and without (in concert with DDR&E), dealing with military construction, maintenance, personnel, and financial management in order to identify ways in which these can be improved relative to laboratories.

d. Examine current policies and practices concerning the weapons-systems involvements of laboratories and take steps to alter them as needed in view of the above objectives.

NAVY COMMENTS ON PROBLEMS OF THE IN-HOUSE LABORATORIES AND POSSIBLE SOLUTIONS

PROBLEM	NAVY COMMENTS
1.1 Mission: This requires definition starting with the very meaning of the word as it relates to the activities of the DOD Departmental as well as laboratory missions require clear definition. The functional and technological interrelationships between the laboratories require analysis. The roles of the laboratories in relation to the program manager SPO systems need clarification. This is a universal problem.	1.1 The Navy agrees that the present mission statements of the several Navy laboratories are not sufficiently definitive. The mission statement should be a terse, clear reason for the activity's existence. As such, they should be concisely stated in terms of technologies, functions, warfare areas or systems responsibilities assigned each activity. The mission statements should be permissive with regard to activity outside the prescribed areas of primary responsibility. Missions should reflect long-time frame Navy requirements to be fulfilled by the activity and thereby serve to guide further reorientations, consolidations or eliminations. A continuing Laboratory Planning Group (established in June 1966) under the Director of Navy Laboratories is examining the laboratory complex in the total environment, considering all resources exclusive of the Fleet. Warfare area concepts are being utilized. This group has completed a delineation of the functional areas now being covered by the Navy laboratories. The efforts in functional areas have been quantitatively related to warfare areas. The analysis of these data with attention to apparent overlaps or omissions in the light of possible contractor abilities is proceeding. This analysis and an estimate of the probable future operational warfares provide a basis for planning levels of efforts and technological mixes necessary in the future. As a result of the warfare area concepts, the Underseas Warfare Center (Los Alamitos) is being designed as a model or prototype. An additional input for this planning will be derived from the eight working groups also set up by the Director of Navy Laboratories early in June 1966. Each group is to make a critical assessment of a designated warfare area in the light of enemy threats for the 1970 decade. An examination of the vulnerability of current systems in the warfare mission area is included. Evaluation of these efforts will provide guidance for future systems requirements and supporting research and development needs.
1.2 General Management and Policy: Great differences exist in the policies, guidance, procedures, techniques and general management concepts being applied in the Defense laboratories. Some are doubtlessly superior to others. No procedure or systematic technique to measure effectiveness and utility of laboratories established to determine relative quality of laboratories. No program in effect to improve, combine or eliminate inferior or marginal laboratories.	1.2 The Navy agrees that standardization of policies, procedures, management techniques, and evaluation has not yet been attained. The diversity of Navy laboratory profiles (from corporate research center, to combined warfare-, system- or functionally oriented laboratories, to test, evaluation or engineering support activities), the variation in size and operating expense, and the diversity in capability to provide supporting services make complete standardization unacceptable. General guidance, management concepts, and policies are being promulgated by the Director of Navy Laboratories, where the necessary flexibility of operation is not thwarted. Adaption of a standard accounting system (Industrial Fund Accounting) to support the resource-management system is being examined. No technique for the uniform measurement of laboratory effectiveness is known. Customer satisfaction appears to be a basic measure. Continuing evaluation and correcting actions are being effected to correct expressed dissatisfaction. Examples are: The proposed Underseas Warfare Center, the planned elimination of NSRDF, Bayonne, and other combinations or reorientations. Since the establishment of the DNL, a staff organizational element has been assigned the function of laboratory appraisal. Participation in the Navy Inspector General's visits, review of all other external inspections, and guidance for internal evaluations are providing the necessary background for identifying the factors that require improvement. Continuing attention in this area will develop standards of measuring parameters that will determine ability to be effective.
1.3. MILCON: Departmental institutional long-range planning is required to	1.3 DNL/DLP recognize the MILCON problem, and review has been undertaken of laboratory programs, one aim being the revision

properly coordinate overall future MILCON requirements with program emphasis rather than to rely on individual laboratory submissions. This is a universal problem.

and updating of Navy laboratory missions and establishing facilities requirements to accomplish the lab mission. All voluntary laboratory facility project submittals are carefully reviewed for conformance with mission requirements. The laboratories are required to screen all available facilities, both in industry and in DOD, which are similar to those requested and to document in the facility project submittal why existing facilities, where available, cannot meet the laboratory requirement.

Agree with the problem of acquiring lab facilities on a timely basis under MILCON procedures. Existing 5-year MILCON plans under the FYDP are rarely adhered to, and minor changes to MILCON procedures cannot be expected to help speed the acquisition of lab facilities. However, amendment of 10 U.S.C. 2353, which would permit the authorization of technical facilities at Government-operated laboratories in a manner similar to that now authorized for contractor-operated laboratories, would provide the Services a means to be responsive to the facility needs of the laboratories.

Action: Preparatory to Navy action, DDR&E action is necessary to establish a policy for separate R&D MILCON package review. A level of funding dependent upon total RDT&E funding should be established. These policies would serve to stabilize an equitable annual capital investment for future R&D and would provide a basis for long-range laboratory planning at the DNL level.

1.4 General Management and Policy: Long-range planning on a total basis rather than by individual resources (project funds, people, facilities, equipment and supplies, travel) is needed because of the tradeoffs that can result in greater effectiveness. A particular need exists for total requirements in terms of skills and disciplines, as well as numbers of people.

1.4 Long-range planning on a total resource basis is in process within the individual field activities. The necessary headquarters coordination and guidance are being developed within the newly established office of the DNL. The central management plans are being examined in the context of total resources, total proposed program, and evaluations of future military threats. Warfare-area analysis presently being pursued, along with implementation of centralized functions under the DNL, will progressively ameliorate this problem area.

1.5 General Management and Policy: Close coupling between laboratories and operating components of the services. This is applicable to most laboratories in all three Departments.

1.5 A unique advantage of Navy in-house laboratories stems from the continuing knowledge and experience of operating components. In order to foster the close coupling of these groups, the DNL has taken the following steps: (1) Mission statements will include assigned responsibilities in areas of introduction of new systems to the Fleet and subsequent engineering support. (2) Warfare concept analysis by laboratory groups has been initiated. (3) Rotational exchange of laboratory personnel at operational analysis activities is being arranged. (4) Laboratories are being encouraged to increase direct liaison with operating units that will utilize the present laboratory development effort.

1.6 Financial - Core Program: The internally generated in-house R&D program is inadequate. This problem is applicable to many laboratories in each of the three Departments. A more substantial "Core Program" under the local authority of the laboratory is needed.

1.6 The Navy Core Program consists of foundational research funds in Category 6.1 and independent exploratory development funds in Category 6.2 to be used at the discretion of the laboratory commanding officer and technical director. The foundational research program has existed for about 10 years and is now funded at the level of $14,728,000. The independent exploratory development program was established in a few laboratories in FY 1965 at the level of $1,500,000. All laboratories were included in the program in FY 1966, and the funding level has been increased to $11,800,000 in FY 1967. In the major laboratories, the Core Program now represents 8 percent of the total in-house effort. Until the results of this major increase in independent funds can be assessed, no goal for the "Core" Program can be established.

Action: The Navy is developing a laboratory program planning procedure which will be established by 1 February 1967. This procedure will provide the laboratories the opportunity to generate plans which can then be incorporated into the FYDP by the sponsors. The Director of Navy Laboratories will ensure that sponsors' reactions are made known to the

	laboratories. In addition, the Director of Navy Laboratories will review Navy's plans for FY 1968 against the total Navy R&D program in Categories 6.1 and 6.2 to identify areas in which in-house programs should be established or increased. Recommendations of this review will be submitted to the Chief of Naval Research and the Chief of Naval Development for implementation.
1.7 Organization and Controls - Supply and Procurement Systems: Often inflexible and overcontrolled. Excessively long administrative lag in processing a contract to the point of signature or obtaining standard items from the Supply System. This is a universal problem.	1.7 In Navy laboratories, the excessive time lag usually occurs in processing unusual R&D contracts, not in obtaining standard items from the supply system. The basic problem lies in the procurement system. The minimum processing-time for high-cost procurements is 3 to 4 months. Any additional delays are the result of poor communications between technical personnel and procurement personnel and must be corrected at the local level. Action: DDR&E examine the ASPR to determine the feasibility of tailoring procurement procedures and procurement office staffing (quantity, quality and experience) to the specific needs and requirements of RDT&E.
1.8 Organization and Controls: There is some duplication of functions and efforts, both in laboratories and in middle-echelon organizations, which results in wasted funds, manpower and efforts. This problem, although somewhat limited, is applicable to and between all Departments.	This problem is primarily limited to 6.1 and 6.2 effort. Close examination reveals very little technological overlap beyond 6.2 effort, although cursory examinations sometimes create false impressions. Some overlap at this stage is not all bad and is necessary to keep a laboratory creative and dynamic. The only way to completely eliminate it is to have one massive DOD laboratory, or at least move in that direction. Navy does not concur in this concept. Some evolutionary improvements can be made, however. As a result of the recent (1 May 1966) change in command structure of the Navy laboratories, such management improvements are made easier to implement. Continual appraisals of the laboratory missions and work load will lead to improved efficiency. Navy and OSD Action: Navy - Annual appraisal of mission and work load of laboratories. OSD - Appraisal by major functions between services to assign lead responsibilities in most fruitful areas.
1.9 Personnel — Military: A career in R&D should be recognized and made more attractive. This is partially recognized to varying degrees by all three Departments.	1.9 Agree with the problem. Suggestions to either eliminate military or establish a specialty R&D group are considered inappropriate. Either would serve to isolate the R&D community from the operating units and tend to make close coupling (Problem 1.5) more difficult. Action: The DNL, through careful screening of prospective laboratory commanding officers, is enhancing the billet. Extension of this practice to the selection for subordinate laboratory billets, will, in time, make more attractive the R&D military career.
1.10 Personnel — Recognition: Some system or approach is needed to provide incentives for effective leadership of the day-to-day activities. This is a universal problem. Also, incentives are needed to reward tough-minded managers who tackle the difficult and unpopular chores such as marginal-people problems, withholding ingrades, turning down work offered or assigned to a laboratory - all, of course, with good and sufficient reason.	1.10 See Problem 1.18.
1.11 Financial — Fragmentation: Numerous small projects cause inefficiency and loss of flexibility, and result in "job-shop" operations. This is applicable to many laboratories in all three Departments.	1.11 Two facets of this problem exist. The first, financial structuring, is discussed under Problem 2.9. The second, program fragmentation, is exclusively discussed here. This problem varies significantly between laboratories. In the spring of 1967, the Director of Navy Laboratories will have available a document describing the planned program at each laboratory. This document will provide a means of identifying technical areas and laboratories in which fragmentation is a problem. Action: The Director of Navy Laboratories, working with NMC element coordinators, project managers, the Systems Commands and local laboratory management, will review fragmented programs and direct

	appropriate action such as: (a) Broader assignments to laboratories. (b) Termination of minor tasks, not beneficial to the laboratory, which can be accomplished elsewhere.
1.12 Personnel — Requirements: Although the Civil Service Commission has fostered the dual promotion system and the "impact of the man on the job" concept, the use of these techniques by the laboratories is surprisingly low. Too often there is a requirement for supervisory duties to justify higher grades.	1.12 Disagree with the problem as stated. Delete "surprisingly." Controls on high-level positions influence organizational structure to be staffed first. In research departments of labs, extensive use of the "man on the job" concept has been made and will continue. Actions required are the big one of reducing controls on high grades (Bureau of the Budget) and Navy action by DNL staff to allocate available high grades to the exceptional few who warrant promotion to the nonsupervisory positions. The problem will never completely disappear, but it can be reduced. Out of 17 GS-14 positions granted to laboratories for FY 1967, five were for promotions in nonsupervisory positions. It is expected that FY 1968 allocations will further alleviate the problem.
1.13 Organization and Controls: Divided executive management between military and civilian heads sometimes leads to misunderstanding or confusion. When this arises, it can be a serious problem.	1.13 Agree that problem is potential. Current SECNAV Instruction 3900.13A delineates responsibilities of commanding officer and technical director and goes far in diminishing the problem. Careful selection of both C.O. and T.D. minimizes potential personality problems in this area. We believe that time will reveal we are exercising the proper care.
1.14 Personnel — Security and Policy Reviews: Clearance of papers for publication or delivery is often too slow to meet the time schedules for presentation. This is a general problem in all three Departments.	1.14 Agree in principle. Authority for approval should be delegated to lower echelons. The need to obtain approval outside the originating agency should be the exception rather than the rule. Laboratories should be given the latitude to determine when higher review is required.
1.15 Personnel — Authority: Requests for authorizations and classification actions are reviewed at too high a level. This is a general problem.	1.15 Agree in principle. Laboratories have classification authority up through GS-15. Authorizations and classifications of PL-313 and supergrade positions are subject to controls from both CSC and Navy. With current restrictions on high-level grades, little can be done about these reviews; however, since the establishment (July 1960) within Navy of the Office of Civilian Manpower Management, a review echelon has been eliminated. One of the objectives of the establishment of the DNL is to assist laboratories in obtaining expeditious action on such matters. This has been and will continue to be done.
1.16 Personnel — Promotion to Management: Increased attention is needed to the selection, education and development of new managers. This is a general problem.	1.16 Agree in principle. Aside from demanding that technical supervisors train and develop new managers, the incumbent supervisors must be educated in the latest techniques of management. To this end, more extensive use of CSC courses and graduate and undergraduate management courses from universities in the locales of the laboratories is necessary. DNL will develop a policy related to management training for technical supervisors and scientists.
1.17 Organization and Controls — Rapid Rotation of Military Directors: The military are not retained in the job long enough to provide adequate continuity or make effective contributions. This is a limited problem.	1.17 Disagree in principle. Navy laboratory commanding officers are designated for tours of 3 to 4 years' duration. A recent Ship Systems Command study indicates that the average tenure of civilian technical directors is only one year longer than that of military commanding officers. Navy will continue to assign commanding officers to tours of 3 to 4 years' duration. Except for isolated areas, the commanding officers serve their normal duration.
1.18 Personnel — Recognition: More diligent application of the systems for recognition of exceptional technical performance is necessary. This is a general problem in all three Departments.	1.18 Agree in principle. More diligent application of the systems for recognition of technical performance can always be made; however, Navy labs have not lagged in rewarding exceptional technical performance, not only of professionals but of technicians and support personnel as well. DNL will seek means to motivate laboratory managers to improve their performance in this area.
1.19 Personnel — Publicity of Examinations: There is a need for better coupling with colleges. This is applicable in varying degrees to all three Departments.	1.19 Agree that better institutional advertising can be done by CSC at colleges. Laboratories are responsible for fostering outside interest in their own installations. Naturally, some do better than others, depending upon the creativity of the IROs. Navy action is being taken by the DNL staff during biannual inspections and by emphasis during periodic discussions with cognizant laboratory personnel. Laboratories are being urged to expand their recruiting regions. In most instances, scientists and engineers are used on recruiting trips to universities. Results have been quite satisfactory.

1.20 General Management Policy — Coupling: Coupling between in-house laboratories and universities with DOD-sponsored research is needed. This problem is of a limited nature but is applicable to all three Departments.	1.20 Most of the Navy-sponsored research is administered by the Office of Naval Research. The need for closer coupling of laboratory and university researchers is recognized. The magnitude of the problem varies between technical areas. In some areas, in-house laboratory personnel assist ONR in administering and monitoring contracts. In other areas there are advisory panels with laboratory membership which generate Navy-wide programs. Action: The Chief of Naval Development and the Chief of Naval Research have established a Joint Research — Exploratory Development Steering Group to provide coupling between the research and exploratory development programs. Subordinate to the Steering Groups, several panels have been established to specifically couple laboratory, university and industrial research/exploratory development efforts. These panels are concerned with materials, lasers, microelectronics, BC/W, etc. The ONR will shortly distribute to all Navy laboratories a list of its university contractors, including their fields of interest and current Navy effort. The labs will be invited to utilize the contract personnel and/or information to their best advantage; all contractors will be informed of this action.
2.1 Personnel: Compensation for people is controlled by (1) average grade, (2) the classification system, (3) high-grade position control and (4) salary budgets. The combined effects of these simultaneous controls stifle initiative and management action in laboratories. This problem is widespread in all Departments.	2.1 Navy labs no longer have an average grade level imposed on them; nor do salary budgets directly affect them, since these requirements do not filter down to the laboratory echelon. Consequently, only the classification system and high-grade position control have any effect on compensation. Navy staunchly supports the classification system. The high-grade control is adverse only because not enough allowances are presently available to the labs. Steps are being taken through the FY 1968 budget submission to give partial relief to the allowance shortage. A strong position management program, designed so that activities critically review their requirements, as related to mission and workload, is presently being formulated.
2.2 Personnel: Although covered generally above, the control over high-grade positions has caused several morale problems in the laboratories and should be singled out as a specific problem. Some relief was provided and applied to Army and Air Force laboratories in FY 1966. The Navy laboratories have had little or no relief.	2.2 Agree in principle. This is the most severe problem facing the Navy laboratories today. Maximum effort is being made to receive an additional 207 high-grade allowances in the FY 1968 budget. This would offer significant relief; however, much of the damage that has already occurred under the restriction is irrevocable. Morale has degenerated, particularly at the GS-12 and GS-13 levels. Many scientists have left Navy for positions at other Government agencies where allowances are more abundant, or have migrated to private industry. Action: Navy — Press for relief. DDR&E — Support relief for the general RDT&E community. BOB — Honor Navy requests.
2.3 Personnel — Authorized Strengths: Flexibility is needed to permit laboratory directors to adjust their personnel strengths and skill requirements to properly satisfy changing workload requirements. Present ceiling controls are too restrictive. This problem is widespread in all Departments.	2.3 Agree in principle. Some relief has been granted, in that temporary employees no longer count against the ceiling. Navy is attempting to manage laboratory ceilings from a central organization - DNL. Initial implementation of control of the ceilings of the 15 laboratories under CNM command is set for FY 1968, but agreements have yet to be formulated with OCNM to allow ceiling flexibility.
2.4 Personnel: A positive, easily administered program is needed for management in dealing with the problem of what to do with the marginal employee. This problem is widespread in all Departments.	2.4 Laboratory and DNL comments on the Federal Science Council Report, Management and the Marginal Employee, have been forwarded. Generally, the problem can be handled within current regulations; however, a more easily administered program would greatly reduce management effort. Further comments regarding utility of the report will be forwarded by the first of the year. The problem can be greatly mitigated at the laboratory level. Since the report and comments were lengthy and contained action items for several agencies, conclusions will not be repeated here.
2.5 Organization and Controls: RDT&E activities are too often required to comply with rules and regulations aimed at logistical, operational, procurement and production organizations, resulting in frustration and inefficiency of laboratories. This tends to destroy the	2.5 Agree with the problem to a limited degree. No two laboratories are exactly alike, and therefore all regulations do not fit all labs. The Navy has been able to abide these matters by granting waivers from instructions where not applicable. A major step was taken on 1 May 1966 when command of 15 laboratories was changed from subordinate commands to the Chief of Naval Material. Labs will be shielded from many nonapplicable regulations. Action is continuing

environment of creativity and innovation. This is widespread in all Departments.	as required by the DNL staff.
2.6 Organization and Controls: Laboratory directors do not have authority over their supporting and administrative services. They are even more inhibited when they are tenants and must obtain their support from a host base, post or station. This is a problem common to all three Departments but not to all laboratories.	2.6 Disagree with implied conclusion of problem, i.e., that without complete authority over supporting and administrative services, lab directors are inhibited. In some cases it is more efficient to allow housekeeping functions to be administered by other commands. In cases where responsibility is not vested in the lab director, he has recourse through fitness reports and common HQ echelon. Minor problems are usually settled at the local level. An administrative channel to higher echelons already exists through the DNL office.
2.7 Program Development: Laboratories are frequently not involved in important systems development decisions in areas where they can make important contributions either to the systems concept or the development cycle. While there are important exceptions, this problem exists in most laboratories in all three Departments.	2.7 The Navy believes the problem to be even more basic in that the laboratories are often not involved in the initial planning stages of the RDT&E program. Proper use of the laboratory technical talent during all of its stages of planning, execution and decision-making would significantly strengthen the Navy's program. Procedures can be developed that will ensure this input. Action: The DNL will introduce and/or expand formal program-planning procedures for all CNM R&D laboratories in FY 1968. These will provide for direct interplay between all program sponsors and the laboratories. As the procedures evolve, they may be extended to include other Navy R&D laboratories. In addition, key laboratory personnel will assist NAVMAT element coordinators in formulating overall technical plans within their respective areas. The DNL has also set up eight working groups to make critical technical assessments of the designated warfare areas in light of enemy threats within the scope of Navy laboratories for the 1970 decade. The evaluations will be expected to provide guidelines for future research, development and test needs, and also to define new systems requirements.
2.8 Facilities: The acquisition of laboratory facilities through the MILCON process is time consuming (averaging 5 to 8 years); out of phase with the need; unnecessarily inflexible.	2.8 See Problem 1.3 and the following discussions.
Alterations to existing facilities are covered by extremely severe regulations which limit the ability of local authority to adjust to changing technology and requirements. When involved in alterations above $25,000, laboratories must compete with operational forces for minor construction funds. This is generally applicable to all laboratories.	Agree with problem. Since FY 1957, when the $25,000 limitation was established, rising costs of labor and material have appreciably reduced the amount of construction that can be obtained today for $25,000. The services should support an increase in the present $25,000 limitation. An increase to $50,000 for minor construction is considered reasonable. Installation of equipment and rearrangement of laboratory space should be separated from regulations governing construction. The establishment of a minor construction control system designed for R&D is not likely to happen; however, separation of equipment installation from minor construction regulations, as noted earlier, will greatly aid the laboratories in meeting the program needs.
2.9 Financial: Controls on fund expenditures are too rigid. Severe restrictions exist on reprogramming between tasks, projects and elements. Too many sources of funds, detailed accounting and justifications are required. There is inadequate decentralization of authority by higher headquarters above laboratories.	2.9 There are several aspects of this problem at Navy laboratories: (a) The number of funding sources, i.e, the number of elements in the RDT&E program, and the controls imposed at the element level. (b) The lack of reprogramming authority at the laboratory level. (c) The use of allotments at laboratories operating under the modified industrial accounting system which, in effect, treats R&D funds as an annual appropriation. There are two ways to reduce the number of elements — restrict the number of elements in which work is assigned to any one laboratory and/or reduce the number of elements in the program. Delegation of reprogramming authority to the laboratories is impractical unless all funds in a single element are allotted to a single laboratory. Any greater fractionation of reprogramming authority than that which now exists will jeopardize the Navy's ability to react promptly to reprogramming requirements. Action: The DNL will review the laboratory programs for FY 1968 to identify minor effort in individual laboratories and elements. The desirability of terminating minor efforts will be discussed with the laboratory so that effort can be focused on major programs and,

	concurrently, the number of fund sources can be reduced. The Chief of Naval Development is planning a restructuring of the exploratory development program, which may result in a request to DOD to revise the element structure. A significant decrease in the number of elements in Category 6.2 would correspondingly decrease the number of fund sources in in-house laboratories.
2.10 Reporting Levels: Too often there is an excessive number of vertical and lateral echelons between the laboratory director and the Assistant Secretary (R&D). Many of these levels are too heavily staffed, and create roadblocks and heavy, unnecessary work loads on laboratories.	2.10 Disagree with the problem. Since 1 May, major Navy laboratories are under the command of the Chief of Naval Material and administered by the Director of Navy Laboratories/Director of Laboratory Programs. Direct access to the Office of ASN (R&D) is thus available to laboratory directors. No action is required.
2.11 Organization and Controls — Supply and Procurement Systems: Often inflexible and overcontrolled. Excessively long contracting and procurement times should be shortened.	2.11 See Problem 1.7.
2.12 Personnel — Moving Expenses: Full reimbursement for transfer when to the advantage of the Government. This problem is universal. It is now under Congressional consideration.	2.12 With the passage of PL 89-516, there is no longer considered a problem.
2.13 Personnel — Interview Reimbursement: Should be provided for prospective employees. This problem is universally applicable. CSC has supported legislation for this but without success.	2.13 Urge vigorous OSD support of HR 9020.
2.14 Personnel — Compensation: Defense laboratories are at a competitive disadvantage for talent in the marketplace, from the entry level of college recruits to compensation for senior R&D managers. This applies to both civilians and military. This is a universal problem.	2.14 Agree in principle. Congressional recognition of the problem is essential. Scientific professionals in Government are considered by CSC only at the lower grades for recruitment at levels above the lowest step. While this is better than nothing, it still does not allow the laboratories to be competitive with industry. The high-grade-level restrictions are particularly oppressive where senior R&D managers and Ph.D. recruits are sought. Not only are the labs noncompetitive in these areas, but potential promotions cannot be offered as inducements. Action: CSC action is required.
2.15 Personnel — Movement: Greater flexibility is needed to readily permit the exchange or movement of professionals among laboratories, between labs and headquarters activities and between Departments to permit required adjustment and marshalling the best defense talents to solve Defense problems and for broadened career development. This is pertinent to all Departments.	2.15 Agree with problem. Schemes to exchange lab and headquarters personnel usually bog down for reasons such as shortage of travel funds, disruption to family life and school situations, and work involvement. Managers faced with making the most of their resources usually decide to disapprove the scheme. Key factors in a successful program are: (1) voluntary; (2) managed and funded from top management; (3) participants with low years of service. Action: Between services — DDR&E. Between laboratories and headquarters — Navy. Presidential plan for Senior Civil Service personnel mobility may set course for application to RDT&E community.
2.16 Personnel — Job Classification: Classifiers are more responsive to narrow interpretations of regulations than to actual technical requirements. Further, supervisors of professionals have inadequate authority over classification. This problem is more widespread in tenant laboratories than in host laboratories.	2.16 Agree with problem. The problem varies in degree among the labs. Only one major Navy lab is a tenant; therefore, the problem is principally one of personalities and can be handled on a local level. Action is assigned to DNL staff to resolve difficulties. While the action must be of a continuing nature, specific efforts to resolve difficulties, where they exist, will be taken.
2.17 Financial — Fluctuations: Often cause difficulties in maintaining an adequate and balanced technical staff. Caused by many factors such as: Too many sources or "pockets" of funds; high-level "project engineering"; fund deferments; and lack of timely decisions. This problem is applicable to all Departments but varies in industry.	2.17 The problem caused by too many sources of funds is discussed under Problem 2.9. Difficulties in maintaining an adequate and balanced technical staff have resulted from fund deferments and lack of timely decisions. Laboratories cannot start deferred programs or proceed with programs for which funds are withheld even though the programs were planned to support particular groups of specialized persons difficult to utilize elsewhere. The accompanying delays also make it more difficult to complete the planned work on schedule and before expiration of the funds, particularly if equipment or material procurement lead time is required.

	Action: Where funds have been withheld within Navy which were planned to support in-house laboratory personnel, the DNL has gotten sufficient funds released to continue the planned level of personnel support. Hence, problem deferments are those made at the DDR&E level. Before deferring or withholding funds appropriated for ongoing programs, ODDR&E should determine the involvement of in-house laboratories in the program, and should release sufficient funds to support the in-house personnel until the program can either be redefined to meet DDR&E objections or phased out in an orderly manner.
2.18 Personnel: New employees' orientation is frequently inadequate. This problem is probably of limited extent in all Departments.	2.18 Agree in principle. Although orientation is standard for new employees at all Navy laboratories, reorientation to managerial duties is sometimes overlooked. Navy corrective action will be taken through Inspector General inspections at 2-year intervals. The new Office of Civilian Manpower Management will, through evaluation of personnel offices, ensure greater consistency of action on this problem. Action is clearly that of laboratories, with headquarters review.
2.19 Personnel — Processing Time: The administrative process for selecting and processing a new employee takes an exorbitant amount of time, particulary for senior, experienced people. This problem is generally widespread in all Departments.	2.19 Agree in principle. Within Navy, it is hoped the time will be reduced now that the Office of Civilian Manpower Management will provide direct personnel administrative services to all laboratories for high-level positions.
2.20 Organization and Controls — Audits: There is an excessive number of overlapping audits in all areas. This is a general problem in all three Departments.	2.20 Agree with problem. This problem reflects the functional management concept under which the Government operates. Each functional area, such as personnel, comptroller, supply, etc., finds it necessary to audit its own function at laboratories. Much of this results from controls emanating from both the Executive Branch and Congress. Navy has tried to mitigate the problem to some extent by declaring a particular month for specific labs as open season for inspections. We have also been successful in reducing the number of inspections. In another instance, labs are asked to make self-evaluations. Since 1 May 1966, DNL has assigned part of his staff to the function of laboratory appraisal. One of the objectives is to coordinate appraisal activities, reduce the number of those originating within Navy, and to increase their meaningfulness. Audits originating in CSC, BuBud, GAO and Congressional staffs should be action of DDR&E. Navy action will be a continuing one of the DNL staff.
2.21 Personnel — Summer Hires and Co-ops: Earlier authorization is needed. This is a general problem of most laboratories. Also, provision should be made for healthy undergraduate and graduate co-op programs.	2.21 This is no longer a problem. Supplement 1 of SECNAV Instruction 5310.6A discontinued the assignment of ceiling authorizations for temporary and part-time employees. Navy already has a vigorous co-op program which is examined at each laboratory every 2 years by the Inspector General.
2.22 Financial — Industrial Fund: Operating under the industrial fund tends to price some activities out of business. This is applicable to a few laboratories in the Army and the Navy.	2.22 The charge that operating under the industrial fund tends to price some activities out of business is misleading. Under the industrial fund the customer pays the true total cost of his work. Government activities operating under other financial systems are subsidized in some way so that the customer is often not paying a share of the overhead costs. The Navy laboratories operating under the Navy industrial fund strongly recommend conversion of all Navy laboratories to NIF. In addition, the ASTSECDEF(COMPT) letter of 17 August 1966 on the subject of "Working Capital" states in part: Major service units will operate under working capital funds. These include units such as arsenals, depot maintenance activities, aircraft overhaul and repair activities, shipyards, certain laboratories and proving grounds. Decision on extension of industrial fund operations to additional laboratories and proving grounds or ranges, repair operations at Navy ammunition depots and weapons stations, and to ship repair facilities overseas will be made after further study. Action: The Navy does not recommend that those laboratories operating under the Industrial Funds be removed from it. A Navy position on extending industrial fund operations to other laboratories will be established by 1 January 1967.

APPENDIX B

PLANNING DOCUMENTATION

Appendix B provides the following samples of requirements for R&D planning documentation:

- Format of Planning Objectives (1951)
- Format of Operational Requirements (1951)
- Format for Development Characteristics (1953)
- Format for Technical Development Plan (1957)
- Reliability and Maintainability Information Required in Requirements Documents and Technical Development Plans (1962).

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FORMAT OF PLANNING OBJECTIVES (1951)

CLASSIFICATION DATE _____

PLANNING OBJECTIVE NO. __

PLANNING OBJECTIVE

This should be stated as briefly as possible but nevertheless should contain all of the vital points.

Derivation of Planning Objectives

1. Background of Problem

   a. Intelligence or other information indicating problem to be met.
   b. Strategic concept posing similar problem to probable enemy.
   c. Effect of failure to solve problem.

2. Requirements for Solution

   a. Capabilities and shortcomings of present equipment.
   b. Minimum requirements for satisfactory solution.
   c. Related countermeasures considerations.

3. Requirement Date (Date or dates by which operational evaluation of equipments developed must be completed.)

4. Relation of this Objective to other Objectives.

Submitted:

Chairman, Research and
Development Review Board

Forwarded, Approval Recommended

_____
CNO

Approved: _____
Under SecNav

Copy to:

RDB NavSec	(25)	ComOpDevFor	(5)	BuY&D	(5)	OP-34	(5)
Comdt, USMC	(5)	BuAer	(15)	BuM&S	(5)	OP-37	(5)
ONR	(20)	BuOrd	(15)	OP-20	(1)	OP-36	(5)
CinClantFlt	(2)	BuShips	(15)	OP-30	(1)	OP-51	(5)
CinCPacFlt	(2)	BuPers	(5)	OP-31	(5)	OP-55	(5)
UnderSecNav	(1)	BuS&A	(5)	OP-32	(1)	OP-04	(5)
						OP-05	(1)

Source: OPNAVINST 0390.1, May 25, 1951.

FORMAT OF OPERATIONAL REQUIREMENTS (1951)

CLASSIFICATION DATE _____

OPERATIONAL REQUIREMENT NO. __

1. Operational Requirement:

Function required to be performed.
Features of desired development work.
Minimum acceptable limits of operational performance.
Weight and space limitations.

Where the scope of the work under any one requirement can be broken down to major subdivisions for better reference and discussion, this is desirable, numbering the subdivisions with Roman numerals. In this case, identify the reference or discussion under the other format headings with the corresponding numeral, if clarification results.

2. Supporting Data and Recommendations:

Any service information or recommendations from the Fleets, Bureaus or other activities that support the need for fulfilling this requirement indicating supporting official correspondence related thereto. The supporting information should be specific. List documents, publications, intelligence reports, letters, etc., which indicates the necessity for the work. Follow with a paragraph stating briefly the contents of the references.

3. Present Equipment Affected:

List (not discuss) existing systems, equipment or standard components that might be superseded or made obsolescent through the achievement of this requirement. Omit identifying numbers in order to avoid the necessity of correcting the format for additions or cancellations of specific projects.

4. Material under Development:

Discuss work now undergoing development which gives premise of essential support to this requirement, giving the estimated date of readiness, cognizant bureau and project number where applicable. This discussion should be confined to major items only, in order to keep it within reasonable limits for Operational Requirements which have many minor projects in progress.

Research in progress should not be listed under this heading, but belongs under 5(c).

5. Research Considerations:

To what extent can the OPERATIONAL REQUIREMENT be met with existing basic and applied research and technical knowledge?

List major known parallel research and development effort being accomplished in other services or friendly countries that might aid the achievement of this requirement.

What further research is required to accomplish the REQUIREMENT? (Clear with the Office of Naval Research).

6. Interim Readiness:

Estimate of interim readiness provided by existing equipment or short term supporting developments to meet possible demands of interim situations. List equipment if desirable.

7. Date Equipment is Required:

Date or dates by which operational evaluation of equipments developed must be completed.

8. Planning Objective and Priority Assignment:

Directly supports Planning Objective Number ___
Indirectly supports Planning Objective Number ___
Priority _____.

Signature: _____
OP-03D, CNR, or MarCorps

Copy to:

Under SecNav	OP-001	BuMed	OP-04
BuAer	OP-30	ONR	OP-04E
BuOrd	OP-31	RDB	OP-40
BuShips	OP-32	CinCLantFlt	OP-41
BuS&A	OP-34	CinCPacFlt	OP-C5
BuDocks	OP-36	ComOpDevFor	OP-51
BuPers	OP-37	ComdtMarCorps	OP-55
			OP-551

Source: OPNAVINST 0390.1, May 25, 1951.

FORMAT FOR DEVELOPMENT CHARACTERISTICS (1953)

CLASSIFICATION DATE_____

APPENDIX NO._____
DEVELOPMENT CHARACTERISTIC NO.___

(EQUIPMENT OR FUNCTION)

1. PURPOSE:

(The following phraseology shall be incorporated under this paragraph:)

"The features, characteristics, and capabilities herein are established as guides for the development of _____."

2. COORDINATION: (The following phrasology shall be incorporated under this paragraph:)

"In any instance where attainment of a particular specification threatens the orderly progress of early realization of the development, the developing agency will immediately advise the Chief of Naval Operations or Commandant of the Marine Corps, as appropriate, and will make appropriate alternative or remedial recommendations."

3. CHARACTERISTICS:

a. Major Features

Describe under as many subheads as necessary the important functions to be performed, the features of the equipment and limitations imposed. These descriptions are guide lines for the design of the equipment. Include such applicable items as speed, range, reliability, storage features, endurance, multiple use, size, etc.

b. Special Features

Describe under as many subheads as necessary special features applicable to this field. Include sub-paragraphs on Cost and Simplicity, Weight and Space, Safety, Other Uses (if any), and Exceptions to the Basic Requirement (if any).

4. DATE COMPLETION OF DEVELOPMENT IS REQUIRED:

a. Date by which operational evaluation of equipment developed must be completed.

5. CROSS REFERENCES:

List all references: those in forwarding letter, those in other Development Characteristics, and any related that may be of assistance.

RESTRICTED
SECURITY INFORMATION

SIGNATURE_____
Op-03D, ONR, or
MARCORPS

Source: OPNAVINST 3910.1, May 20, 1953.

FORMAT FOR TECHNICAL DEVELOPMENT PLAN (1957)

SECURITY CLASSIFICATION

Technical Development Plan (TDP) - A TDP will be prepared by the "Lead" or "Action" Bureau for each Operational Requirement that calls for a system or long lead-time component. The following general format and content for the TDP is suggested, but may be modified as necessary.

Part I

a. A functional-flow block diagram for the complete system in which each block represents a major component (i.e. detection equipment, etc.) of the system.

b. A table of critical operating characteristics for each equipment and major component giving the "minimum acceptable limits of performance" for each characteristic.

Part II

a. A table (keyed to the functional block diagram) of in-service or other available major equipments that can be used satisfactorily as components of the system.

b. A table (keyed to the functional block diagram) of equipment that must be developed (i.e. specific development item proposals) in order to complete a satisfactory system.

c. A discussion of alternate technical methods as applied to each "development item", with conclusions on the "best" technical method.

d. A table of critical technical characteristics for each development item proposed with estimates of the values for each characteristic that "reasonably" may be expected from the state-of-the-art.

Part III

a. A discussion of the interaction of the system with associated systems. In the case of electronic systems or components, particular attention should be devoted to the problem of mutual interference and the careful selection and proper clearance of necessary frequencies.

b. A table of the critical technical characteristics pertinent to these interactions, with estimates of the values for each characteristic that may be "reasonably" expected.

Part IV

a. A production-type time-schedule for the development of the complete system, including management planning, procurement of development items, procurement of on-the-shelf items, assembly and test of the complete system.

b. Cost estimates for the development of the complete system, including (1) each development item, each major on-the-shelf item, system assembly and test, etc. and (2) aggregate costs for each FY throughout the overall development schedule proposed.

Part V

a. The review of a TDP will identify the equipments and other major components that must be developed.

b. The approval of a TDP will constitute authority to originate development characteristics.

c. Each TDP will generate a project.

d. A project may be divided into two or more sub-projects to identify well-defined parallel or sequential functional groups of equipments.

e. Each project will be divided into a number of tasks:

(1) One task will be established for each equipment or major component that is to be developed (Note: a formal Development Characteristic should be issued for each equipment or major component that is to be developed). A task will include all work on the development from conception through engineering model testing.

(2) A task will be established for a feasibility (or choice of of techniques) study -- whenever such is required.

(3) A task will be established for the overall assembly and test of each sub-system (sub-project), when required.

(4) A task will be established for the overall assembly and test of the complete system.

(5) A task(s) will be established for the development of materials or components, when such is required.

Source: OPNAVINST 3910.2, November 5, 1957.

RELIABILITY AND MAINTAINABILITY INFORMATION REQUIRED IN REQUIREMENTS DOCUMENTS AND TECHNICAL DEVELOPMENT PLANS (1962)

A. Technical Development Plans (TDPs)

TDPs will normally include the kinds of information listed in C below. These lists are not intended to be complete, to be mandatory or to suggest priority or arrangement. Comprehensive reliability and maintainability programs for feasibility studies, exploratory developments and Advanced Development categories are not desired. However, due consideration shall be given in all characteristics, including reliability and maintainability, in the early planning and feasibility study stages, and comprehensive reliability and maintainability programs are expected for operational development projects. It is intended that both the human and hardware aspects of reliability and maintainability be considered. The goal is a balanced and integrated effort aimed at optimizing operational effectiveness, total cost and early availability.

Although adherence to a strict format for the TDP is less important than inclusion of adequate information, it is suggested that TDP sections entitled "Reliability Program" and "Maintainability Program" be provided to highlight the existence and adequacy of such programs.

B. Fundamental Requirements Documents

Fundamental requirements documents (SORs, GORs, MCs, ORs, etc.) will normally include the kinds of information listed in C (1) and C (2) below.

C. Kinds of Information Required

Normally the item listed in (1) and (2) below, which are essentially the requirements, will be precisely and quantitatively stated. Information in the TDP responsive to (3) and (4) should outline the plans for achieving reliability and maintainability, including the significant elements. In some cases, listing of a significant element without detail is satisfactory. For example, indication that reliability apportionment and prediction is a part of the reliability program may be sufficient. In other cases, for example, reliability test and demonstration, principal details of the planned program are necessary. Whenever there is heavy emphasis or unusual treatment of an element, this should, of course, be detailed.

(1) Operational Information that affects reliability and maintainability design

- Planned deployment
- Reaction time required
- Mission duration requirement for each type of mission
- Turnaround time required (e.g., for aircraft, the elapsed time from landing to take-off assuming no repair action)
- Overall mission reliability for each type of mission
- Availability or combat ready rate (percent or number of an item capable of performing the designed missions vs. the total number of items)
- Maintenance and operating environmental conditions (climate, facilities, support, etc.)
- Planned utilization rate (concerns the number of hours, miles, firings, flights, etc., per unit of time)

(2) Planning information needed for reliability and maintainability design

- Mean-time-to-return-to-service goals
- Reliability after storage goals (e.g., 90% reliability after 3 years storage)
- Minimum allowable time between scheduled maintanance
- Test and checkout philosophy (extent of automaticity, complexity of test, degree of fault isolation at various echelons, special vs. multi-purpose test equipment, etc.)
- Echelons of maintenance of maintenance concept to be used and specific maintenance responsibilities for each
- Maintenance and crew personnel (numbers and skills) and training allocated for support of this program

(3) Plans for a reliability program outlining how reliability will be achieved

- Determination of equipment environmental conditions (system, subsystems, parts, etc.)
- Periodic specification review (when, how often, etc.)
- Reliability apportionment and prediction
- Reliability design reviews
- Human error analysis and prediction
- Reliability test and demonstration
- Malfunction and failure reporting and analysis

(4) Plans for a Maintainability program outlining how maintainability will be achieved

- Quantification of maintainability (concerns the development and application of numerical measures of maintainability. This also involves allocation of overall system measures of maintainability to all major lower-order elements of the system. Mean-time-to-return-to-service is an example of one such measure.)
- Maintainability prediction (extent, schedule, design, influence, etc.)
- Maintenance task and skill analyses
- Maintainability design reviews
- Test and demonstration
- Maintenance data collection, feedback and analysis

Source: Department of Defense Instruction, 3200.6, June 7, 1962.

APPENDIX C

SAMPLE NAVY TECHNOLOGY FORECASTS

Appendix C consists of the following samples of the Navy Technology Forecast:

- Part I (Scientific Opportunities)–Plasma and Ionic Physics
- Part II (Technological Capabilities)–Nonmetallic Composites
- Part III (Probable Systems Options)–High Mach Gas Turbine Engine.

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SAMPLE NAVY TECHNOLOGY FORECAST

PART I—SCIENTIFIC OPPORTUNITIES

PLASMA AND IONIC PHYSICS

INTRODUCTION

Plasma and ionic physics is the study of the properties of matter in the ionic and plasma states to obtain a comprehensive understanding and technological control of the phenomena in both the microscopic and macroscopic domains. It also includes the study of electron transport within conduction bands of metals, and ion-surface interactions.

PRINCIPAL SUBDIVISIONS

Collective Effects (including electron and ion waves, electrical conductivity, viscosity, and thermal conductivity)
Individual Effects (including motions in electric and magnetic fields)
Electromagnetic Waves in Plasmas
Plasma Hydromagnetics and Electrogasdynamics
Plasma Instabilities and Containment

A. BACKGROUND

This article deals with plasma and ionic physics research and potential. Emphasis will be on the technological and military needs and possibilities. Other research areas which are a necessary input will not be stressed, but will be dealt with here briefly.

Plasma physics as such cannot be strictly separated from atomic and molecular physics. The complete study of a plasma involves the measurement or calculation of the densities of particle constituents and their velocity distributions. Wave propagation in the plasma and natural decay mean that the densities and velocity distributions vary with time. Reaction rate constants which determine variation of species concentrations with time are given by integrating, with respect to velocity, the product of velocity, cross section, and distribution function. Thus, electron-atom and electron-molecule collision cross sections, both elastic and inelastic, are required to interpret plasma data. Alternately, if velocities and velocity distribution functions are known, cross sections can be estimated from plasma species concentration measurements.

A consistent backup capability in atomic and molecular research and interrelation with plasma physics is essential for progress in plasma research. This applies not only to experimental work, but also to the theoretical quantum mechanics of collision phenomena. Although electron-atom collisional processes are at present amenable to theoretical treatment, electron molecule collision data, due to vibrational and rotational states, is largely dependent on experiment.

Plasma physics itself must have a very strong input of theoretical work. This is true not only for electromagnetic and wave phenomena, but also for the particle kinetics of plasmas and the solution of transport equations, which are often nonlinear.

Another aspect of plasma physics is its interaction with laser work. Lasers are now used not only to produce ionized gases (plasmas), but also to diagnose plasmas. Laser physics is thus making significant contributions to plasma research.

An understanding of thin and dense plasmas and their interaction with electromagnetic fields is necessary for the improved operation of satellites, missiles, space probes, and communication and weapon detection systems. An integrated theoretical and experimental program is required to resolve a number of questions relating to the dynamics of fully and partially ionized gases. Topics involve magnetohydrodynamic shock structure in partially ionized gases, collision-free shock formation in fully ionized gases, and subsonic plasma flow in inhomogeneous magnetic fields. Nonlinear plasma phenomena govern electron density fluctuations. Solar activity and nuclear explosions create strong atmospheric disturbances by means of the above phenomena; these disturbances affect communication and navigation systems. An important aspect of plasma physics is magnetohydrodynamic power and the possibility of controlled thermonuclear power.

B. PRESENT STATUS

Collective Effects

Plasmas in the form of ionized gases have engineering uses such as electric switches, rectifiers, and arc

and discharge lamps. Plasma effects also occur in metals and semiconductors. The conduction electrons of solid conductors and semiconductors move through the crystal lattice under external magnetic and electric fields and can thus support plasma wave propagation. The electrons and associated holes behave as free particles. To observe plasma-wave phenomena in solids, the relaxation time of the charge carriers due to scattering from thermal lattice vibrations, impurities, and faults must be so low that the wave phenomena are not damped out. This dictates the use of high-purity samples at liquid-helium temperatures. These effects in semiconductors have applications to device technology such as oscillators, amplifiers, and switches. The possibility of ionic propulsion is another facet of plasma physics. Further, ionization effects in plasmas are important for radio-frequency communications and telemetry from space and re-entry vehicles. During part of every re-entry from space, radio transmission to and from the re-entering vehicle is blacked out by the plasma sheath that forms as material is ablated from the heat shield and the air behind the re-entry shock wave is ionized.

Individual Effects

Plasmas contain nearly equal numbers of positive and negative charge and these charges can oscillate. From considerations of average kinetic and potential energy and restoring forces, a critical length $l = (kT/4\pi ne^2)^{1/2}$, which must be less than any other characteristic plasma length, and a critical frequency $\omega = (4\pi ne^2/m)^{1/2}$, below which oscillations will not take place, can be defined. (n is the electron density.) A further characteristic is the root-mean-square electron velocity, $v = 3kT/m$. Ionization energies of atoms range from electronvolts to thousands of electronvolts, and since 1 eV corresponds to 11.6×10^4°K, temperature ranges of 10^2 to 10^9°K are possible. Corresponding electron densities per cubic meter run from 10^4 to 10^{24}.

Although the collective effects usually predominate in a plasma, motions of individual electrons and ions in electric and magnetic fields are important, as well as interactions between the ions and electrons themselves and with surface areas.

An important area of ionic physics is that of ion-surface interactions. Sputtering is the disintegration of a solid surface caused by bombarding it with high-voltage ions. Since the ejected atoms can be deposited on a substrate, this gives a method for constructing thin films, atom by atom. High-melting-point materials like tantulum, tungsten, and ceramics can be deposited for use in microelectronics technology. Sputtering can also be used for surface cleaning and vacuum pumping. A characteristic of sputtering is that material is always transferred in the same composition, so that the deposited films have the same composition as the original target, even if the target is some complex alloy.

Electromagnetic Waves in Plasmas

Bursts of plasma emitted from the solar surface are called solar flares. As this plasma traverses the solar corona, it induces plasma oscillations which radiate electromagnetic energy. The effect of flares on the earth's ionosphere is important for radio-frequency communications. Flares can also cause sudden changes in the earth's magnetic field, probably due to shock waves induced by the flare which propagate through the interplanetary plasma. From the point of view of navigational satellite systems, the refraction of radio waves by the ionosphere is involved in the determination of position. Changes, and understanding of the causes of change, in the ionosphere are thus important for navigational technology. Nuclear weapons generate electromagnetic waves, including x rays, as well as gamma rays and neutrons. The transmission of the high-frequency signal through the disturbed ionosphere can be used for detection and diagnostic purposes, provided the propagation characteristics of the medium are understood and calculable.

Plasma Hydrodynamics and Electrogasdynamics

Plasma hydromagnetics involves the application of magnetic fields to moving plasmas. The magnetohydrodynamic generator offers a means of converting the thermal energy of combustion, fission, or fusion directly to electric power without the use of mechanical generators. A hot plasma is expanded through a channel with a magnetic field transverse to the plasma flow velocity. The resulting force on the flowing ions and electrons drives them to opposite sides of the channel, giving rise to a potential difference, which can be used to drive current through an external circuit. For large power-generation plants, the efficiency of this generator is expected to exceed steam-generator efficiency. Magnetohydrodynamic generators produce low-voltage high-current electricity.

Although a plasma is strictly a collection of free, charged particles such that the net uncompensated

charge is small compared with the charge of either sign, electrical phenomena in gases, such as corona discharges, have related transport and conductivity properties and are often included in plasma physics as limiting cases. In this respect, the use of electrogasdynamics to generate electrical power can be contrasted with magnetohydrodynamic power. In electrogasdynamics, a flowing neutral gas is ionized by applying an electric field across electrodes at the start of a duct. The ionized molecules produced are blown downstream before they can drift to the negative electrode. The work done by the gas in driving the positive stream against an electric field applied at the end of the duct produces high-voltage dc electricity. The output current is low. In contrast to plasma hydromagnetics, electrogasdynamics is the study of a flowing gas containing excess charge and an applied electric field. Both hydro systems produce electric power directly without the use of mechanical generators.

Plasma Instabilities and Containment

Controlled nuclear fusion of deuterium with tritium would produce a power supply of almost unlimited extent. Practical cross sections (about 10^{-24} cm^2) occur at about 50 thousand electronvolts of energy. For a plasma temperature corresponding to 50 thousand electronvolts (about 10^9°K), the pressure of a plasma of electrons, deuterium, and tritons is about 30 atmospheres. To contain such a pressure, a magnetic field of about 30,000 gauss would be required. For electron densities of about 10^{14} per cm^3, confinement times of about 1 sec and reacting volumes of about 10^6 cm^3 are required. The technological problems in producing a fusion reactor are formidable. However, controlled nuclear fusion is a possibility and research over an extended period is certainly warranted. Fusion devices are often classed as open or closed. The former include mirror machines. The latter involve ring machines. Superconducing cores are now possible. In recent years, progress in plasma physics has meant better intercomparison between theory and experiment. Problems of instability, both macroscopic and microscopic, still exist.

C. FORECAST

Some possible results of the present trends in plasma and ionic physics research which could lead to naval applications are: microwave and millimeter wave oscillators and amplifiers based on plasma states occurring in solid-state materials; sputtered-coating procedures applicable to large-scale objects; materials having low sputtering yields for special applications such as ion engines and plasma containers; electrogasdynamics applied to cleaning polluted air; magnetohydrodynamic generators for use as aircraft powerplants; and ground-based generators capable of producing billions of watts of power.

D. NAVAL AND SCIENTIFIC SIGNIFICANCE

From the viewpoint of naval and scientific significance, the areas of collective effects and plasma electromagnetic waves are at present in use as part of programs in ballistic missiles, atomic weapons effects, surveillance, and navigation. Emphasis is on the work *part*, as the areas in themselves are not device-oriented in general. Studies, however, of plasma effects, and calculations and computer codes, are a necessary backup to operational procedures. The exception is in the case of gaseous electronic devices, which are well known and, in some instances, have been supplanted by solid-state equivalents. The Navy will continue to use data in plasma physics and need to obtain improved data for successful further developments in missiles, atomic weapons, navigation, and surveillance.

Bulk negative conductance in semiconductors is a plasma effect. Oscillators and amplifiers can be based on this phenomenon and the associated space charge. The generation and amplification of microwaves and millimeter waves are thus possible, and this should lead to a whole range of new communication devices.

The technique of sputtering is at present in mass-production use for microelectronics. Here the items coated to produce transistors and capacitors are quite small. Large-scale coating procedures are still in the future but are certainly worthwhile investigating. Other aspects of potential payoff are in the study of materials with low sputtering yield for use, for example, in containers for plasmas in nuclear fusion research. This would reduce the amount of contaminant in the plasma. Similarly, ion engines for space propulsion suffer from erosion due to sputtering caused by the ion stream itself. Again, obtaining suitable materials would do much to solve this problem.

Plasma hydromagnetics and electrogasdynamics are at present operable for power sources. Electrogasdy-

namics can also be used for cleaning polluted air, and in compressor applications. These areas certainly give rise to research products for exploitation. Lightweight magnetohydrodynamic power generators for airborne uses may well produce megawatts of power with operational periods extending to several hours. Gigawatts of ground-based magnetohydrodynamic power also seem possible.

In summary, the areas in gaseous plasmas in which there is a possible current exploitation for naval needs are thus sputtering, magnetohydrodynamic power, and electrogasdynamics. Solid-state plasmas can be exploited for millimeter and microwave generators and oscillators. Nuclear fusion plasma research is another area in which technological research has long term payoff.

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Gourdine, M.C., "Electrogasdynamics," Science and Technology, p. 50, July 1968

Young, F.J., "Magnetohydrodynamics," Proc. IEEE, p. 1408, Sept. 1968

Ingraham, J.C., "Plasma Physics, Handbook of Physics," McGraw-Hill, p. 4–188, 1967

F. ASSOCIATED R&D ORGANIZATIONS

Naval Research Laboratory

ONR Contract Research Program:

- Howard University
- Northwestern University
- Cornell University
- University of California (Los Angeles)

Source: Furnished by the Office of Naval Research

SAMPLE NAVY TECHNOLOGY FORECAST

PART II—TECHNOLOGICAL CAPABILITIES

5 Support Technologies
5F Materials and Components
5F4 Composites
5F402 Nonmetallic Composites

Prepared by: Naval Ordnance Laboratory, White Oak
P. W. Erickson, F. R. Barnet, J. Goan

A. BACKGROUND

(U) In this projection, the discussion is limited to those composites with organic matrices and to reinforcements noted mainly for their ability to provide a high level of mechanical properties in the composite. These organic composites are unique in their high strength-density ratios, good shock resistance, high corrosion resistance, high electrical resistivity, low thermal conductivity and ease of fabrication. Glass fiber reinforced plastics are presently the principal composites in use. Glass is also used in the form of hollow spheres to produce a syntatic foam for high strength buoyancy materials. Composites based on boron fibers, which have exceptionally high strength, could become important if the cost and toxicity problems are reduced. Graphite fibers, which have very high modulus and high strength-density ratio, are the most promising reinforcement for future high performance composites.

B. PRESENT STATUS

(U) The performance of composites depends on the related factors: (1) the reinforcement, (2) the resin matrix, and (3) the interface. The current status is outlined below.

(U) B-1. Reinforcements: The present properties of continuous fiber glass reinforced organic composites are included in the projections in Figures 1 and 2. At present, no other reinforcements can compete in terms of high strength-density ratio combined with low cost. However, boron and graphite fibers are being developed and their present properties are included in Figures 1 and 2. Their cost, at present, is prohibitively high, but with increased demand and advanced technology the prices should be considerably reduced. The use of glass microspheres in syntactic foams presently yields buoyancy materials with a density of 42 p.c.f. and hydrostatic compressive strength of 22,000 p.s.i.

(U) Reinforcing materials consisting of short elements, such as whiskers of metals, metal oxides, metal carbides, graphite, or even diamond, are also being investigated (reference 1, also, see Figure 3).

(U) B-2. Resins - Epoxy resins are found to possess an optimum combination of high strength, good adhesion to fiber reinforcements, and resistance to aqueous environments. Further improvements in their strength are expected to result in increased strength for fiber reinforced composites. For details see Section 5F 301 (High Strength Plastics), Resins which can be used as the matrix for composites intended for use at especially high temperatures are discussed in Section 5F 302 (High Temperature Plastics).

(U) B-3. Interface - The strength of a composite is critically dependent on the adequacy of the adhesive bond at the interface between the matrix and the reinforcement. The interface problem is still not completely understood or solved in glass fiber composites (reference 2) or syntactic foams. The state-of-the-art is, however, very satisfactory as a result of a great deal of applied research and very effective treatments for glass fibers. The situation with boron is not well defined, but there has been Air Force contract work to study the interface problem with boron. A great deal of research is desirable on the surface chemistry of graphite fibers. Up to about three years ago, the interlaminar shear strengths on composites made with high modulus filament wound graphite fibers were unacceptably low. Several empirical approaches now show promise. Oxidation of the fiber surfaces under controlled conditions at NOL and elsewhere have led to an increase in shear strength from about 3500 to about 7500 p.s.i. The British have treatments that result in 11,000 p.s.i. shear strengths which is effective only on fibers of moderate stiffness. The growing of silicon carbide whiskers on graphite fibers had led to composites which fail to break in shear (reference 3) at levels above 12,000 p.s.i.

C. TECHNOLOGICAL PROJECTIONS

(U) C-1 - Glass Reinforced Composites - Small but significant improvements in their properties will occur in the next 20 years (Figures 1 and 2). A 20 million p.s.i. modulus is an expected goal and the tensile strength should increase correspondingly. Syntactic foam buoyancy materials utilizing glass microspheres will be available with a density of 30 p.c.f. by 1975, for use at a depth of 20,000 feet (8900 p.s.i.).

(U) C-2 - Boron Composites - There is an overwhelming probability that the use of boron-reinforced composites will increase a thousandfold in the next decade if competition with graphite composites is not too great. For expected properties see Figures 1 and 2.

(U) C-3 - Graphite Composites - Graphite composites have the greatest potential of the high modulus reinforced plastics (Figures 1 and 2) assuming a solution is found to the problem of their low interlaminar shear strength. The properties of graphite fibers are improving rapidly, e.g., a material with 100 million p.s.i. modulus should be marketed soon. Ultimately, the price of graphite fiber should become lower than that for boron.

(U) C-4 - Plastic Matrices - High strength matrices and high temperature matrices are discussed in Sections 5F 301 and 5F 302.

(U) C-5 - Composites Containing Discontinuous Fibers and Whiskers - High performance composites made with discontinuous, high modulus fibers and whiskers should be important structural materials. These fibers include graphite, boron, glass, alumina, while whiskers include sapphire, alpha silicon carbide, beta silicon carbide, silicon nitride and even diamond, Figure 3. The highest specific properties are found in whiskers, e.g., one million p.s.i., and the moduli are also high.

D. OPERATIONAL IMPLICATIONS

(U) Several analyses have been made of the potential weight savings in air frame structures by replacing metal with high performance composites. The structural weight of the X22A, a VTOL airplane, could be reduced from 4850 to 3300 pounds by replacing part of the metal structure with graphite

composites. This savings more than doubles the payload. Similar analyses have been made on the F111 fighter plane and helicopter rotor blades. The latter application is particularly suitable for composites. In the case of the SST supersonic transport, composites should play a big role, considering that a weight savings of one pound is worth about $350. In many cases, no such economy of cost to weight results, and, for these, the lower priced glass composites or even certain metals may suffice.

(U) The use of molding compounds containing discontinuous fibers or whiskers will receive impetus from the fact that they are stronger than cast aluminum in specific strength and specific modulus. Secondary structures of all kinds are possible applications for such composites.

(U) In the area of submersibles, there are the obvious filament wound pressure vessel applications. A related application is the construction of a 25-foot forward section of a submarine, using preimpregnated glass tape.

E. REFERENCES

1. (U) Economy, J. and L. C. Wohrer, "The Potential of Whisker Reinforced Plastics," Plastics Design and Processing, p. 31, July 1967.

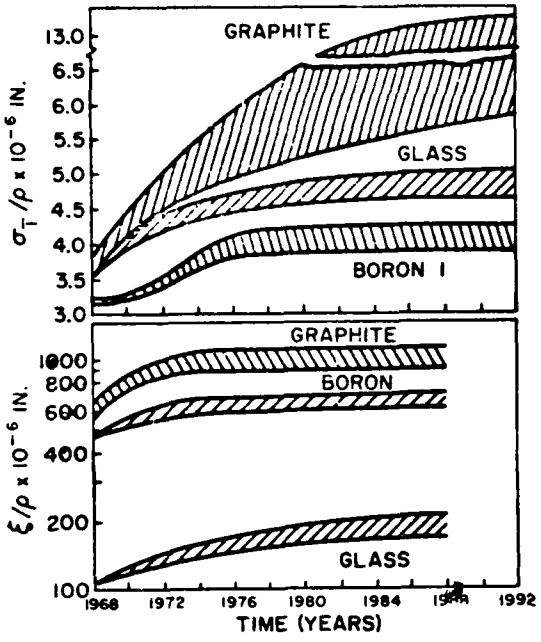
2. (U) Journal of Adhesion, Vol. 2, July 1970. (Report of the Symposium on Adhesives).

3. (U) Simon, R. A. and S. P. Prosen, "Graphite Fiber Composites; Shear Strength and Other Properties," Proceedings of Reinforced Plastics/Composites Division, SPI Section 16-B, Feb 1968.

F. ASSOCIATED ACTIVITIES

Naval Weapons Center (NWC), Corona, California
Naval Air Development Center (NADC), Johnsville, Warminster, Pa.
Naval Ship R&D Center (NAVSHIPRANDCEN), Washington, D. C.
Naval Ship R&D Laboratory (NAVSHIPRANDLAB, Annapolis), Annapolis, Md.
Naval Research Laboratory (NRL), Washington, D. C.

Source: Furnished by the Office of the Chief of Naval Development

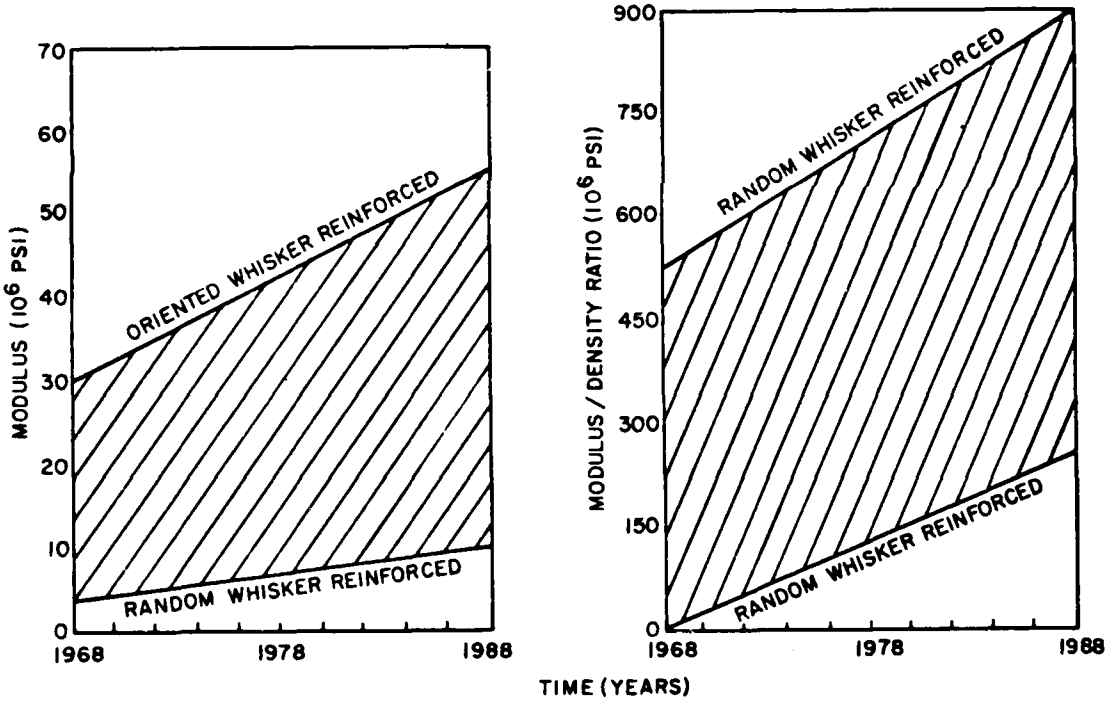


FORECAST OF ROOM TEMPERATURE SPECIFIC TENSILE STRENGTH OF EPOXY FILAMENT WOUND COMPOSITES (35% RESIN)

FIGURE 1

FORECAST OF ROOM TEMPERATURE SPECIFIC MODULUS OF EPOXY FILAMENT WOUND COMPOSITES (35% RESIN)

FIGURE 2



MODULUS AND MODULUS/DENSITY IMPROVEMENTS PREDICTED FOR WHISKER REINFORCED COMPOSITES

FIGURE 3

SAMPLE NAVY TECHNOLOGY FORECAST

PART III—PROBABLE SYSTEMS OPTIONS

HIGH MACH GAS TURBINE ENGINE

A. NEW CAPABILITIES

(U) Increasing Mach number and altitude capability of potential threats have brought about the need for high altitude, high Mach number interceptor aircraft. A gas turbine engine capable of acceleration to and cruise at Mach numbers as high as 3.5 substantially improves the performance of fleet defense interceptors. Gas turbines have been produced for operation at high Mach numbers but have proven to be large and heavy resulting in aircraft much too large for fleet use. Recent gas turbine technology advances have made it possible to produce much smaller and lighter engines that operate more efficiently throughout the flight regime. These engines allow production of lightweight aircraft sized for carrier operation. The high Mach engine will have high thrust for rapid acceleration through the subsonic and low supersonic flight regimes and efficient high Mach cruise operation for long range. It will be necessary to provide extensive performance analysis of the propulsion system to insure the use of the exact components that will yield optimum engine and aircraft performance as well as minimum take-off-gross weight for specified mission requirements.

B. TECHNICAL APPROACH

(U) A number of engine configurations are available for use in an application that requires up to Mavh 3.5 operation. Each cycle has advantages and disadvantages with the final selection depending on the mission profile that is chosen for the weapons system. A representative powerplant considered for development under this program is a single spool afterburning turbojet with a bleed cycle that allows air to bypass a portion of the compressor and go directly to the afterburner for Mach 3.5 cruise operation. This cycle would probably be especially attractive for a mission with a large amount of high Mach cruise. Recently improved technologies which result in a lightweight relatively small volume engine include a high thru flow compressor with high pressure rise per stage; a high output and variable cycle requirements; variable geometry high temperature turbine which also improves subsonic cruise operation and provides better inlet-engine matching; short efficient afterburner; and a lightweight exhaust nozzle with good performance at both subsonic and supersonic Mach numbers.

(U) Other powerplant configurations that should be considered include a duct burning turbofan, a maximum temperature turbojet with afterburner and a fuel rich operation maximum temperature turbojet. The duct burning turbofan would be especially attractive if the mission includes a large amount of subsonic cruise or loiter operation. A maximum temperature turbojet will provide better fuel consumption characteristics than afterburning turbojet but may not be capable of attaining Mach numbers higher than 3.0. The fuel rich operation engine has all the characteristics of the maximum temperature engine except that additional fuel is added in the main combustor to burn the cooling air used in the turbine. This burning actually takes place downstream of the turbine like an afterburner but eliminates the length and weight of afterburner fuel controls, injectors, and mixing section. Because the fuel rich engine is essentially an afterburning turbojet it can attain Mach numbers as high as 3.5 efficiently.

C. OPERATIONAL EFFECTIVENESS

(U) The proposed propulsion system will make it possible to develop Navy aircraft that will fly at high altitudes and Mach numbers while maintaining a realistic take-off-gross-weight for carrier operation. The high Mach capability will provide more rapid intercept of potential threats at a greater distance from the fleet. Also, because potential threats may have greater Mach and altitude capability than present Navy aircraft, an interceptor has only one chance at a kill with no inspection capability. High Mach and altitude capability for Navy aircraft allows an intercept chance for a kill and/or the capability to turn and inspect the threat before deciding if a kill is necessary.

(U) It should be noted, that the propulsion system developed for this application is applicable as the core engine for combination cycle engine which is required if higher Mach numbers than 3.5 are desired.

D. CRITICAL TECHNOLOGIES

(U) The following technology developments are necessary to allow complete development of the proposed propulsion system.

1. High Temperature Materials - high temperature materials may be the pacing item for a high Mach number propulsion system. Materials are not only required for the combustor and turbine but also for the high pressure stages of the compressor, afterburner liners and exhaust nozzle. The afterburner and exhaust nozzle are especially critical because of the lack of low temperature air available for cooling at high Mach numbers.

2. High Temperature Turbine and Combustor - for high Mach operation it is desirable for the combustor to operate at as high a burner discharge temperature as possible in order to realize maximum efficiency and specific thrust from the propulsion system. The propulsion system will also benefit greatly from a variable geometry turbine for low power operation. Work is now in progress throughout the government to develop high temperature variable geometry turbines for a number of applications and thus this technology, although critical will most likely be available without additional funding.

3. High Through Flow Components - both the compressor and burner must be designed to gain the maximum airflow per unit area to minimize system volume and weight.

4. Short Afterburner - a swirl burning or other similar short afterburner will be necessary to reduce weight and volume as well as reduce cooling flow requirements.

5. Lightweight Exhaust Nozzle - the requirement of lightweight in the exhaust nozzle is in direct conflict with excellant performance over a wide range of flight Mach numbers and high temperature operation with a minimum of cooling airflow.

6. Propulsion System Controls - high response controls for the inlet, engine and exhaust nozzle will be necessary to maintain this propulsion system in stable and safe operation. Expecially important for the engine is the capability of controlling turbine inlet temperature at the high levels to be used for this system. It will also be important to integrate engine/inlet controls for the possibility of inlet unstarts which may cause the aircraft to go out of control.

E. REFERENCES

1. Performance Effects Navy (PEN) Program (U) Volume II Program Results (U) McDonnell Douglas Corporation Final Report #170, 6 February 1970, Confidential

2. High Temperature Combustor/Turbine Program (U) Final Engineering Report, General Electric Company, October 1972, Confidential

3. Proposal For An Advanced Technology Compression System, Pratt & Whitney Aircraft Proposal No 72-3390, 8 December 1972

F. ASSOCIATED R&D ACTIVITIES

1. Contributor: Naval Air Propulsion Test Center (PE4)

2. Coordinator: Naval Air Systems Command (AIR-330)

3. Originator: Naval Air Propulsion Test Center (PE4)

G. TIME READY FOR ADVANCED DEVELOPMENT

(U) The high temperature turbine and combustor components are presently being studied in advanced development programs. The other components and much of the materials work are being studied in exploratory development programs and will not be ready for advanced development before FY 1976. With concentrated exploratory and advanced developments efforts it would be possible to have a high Mach demonstrator engine available by FY 1978.

Source: Furnished by the Office of Chief of Naval Development

APPENDIX D

MAJOR NAVY DEVELOPMENT PROJECTS 1946-1973

The following is a list of major Navy projects which entered development and were concluded during the era. Dates shown are either the year the system/equipment was considered to be operational or the year it was cancelled (indicated by an asterisk).

The sources used in the preparation of this list were not always consistent in the dates projects entered development and were certified as operational. To remedy this, the list was checked by representatives of the Navy's systems commands, but not all of the inconsistencies were resolved. Additionally, the source that provided the major share of the data for the "Other Systems" section of this Appendix presented material only for the 1957-1973 period. Consequently, there are no systems developments shown in this section prior to 1956.

AIRCRAFT

1947-HO3S
1948-HTL
1949-AJ(A-2)
1949-F9F-2/-5
1950-HO4S
1951-F3D
1951-HUP
1951-HRS
1951-HTE
1952-P-5
1952-WV
1952-F9F-6/-8
1952-HO5S
1953-HOK
1953-HTK
1953*-J-40 Engine
1953*-F10F-1
1954-F7U
1954-S-2
1954-FJ-2/-4
1954*-A2D-1
1955*-HSL-1
1955-HSS-1
1955*-F2Y-1
1956-A-4
1956-F4D
1956-A-3
1956-F3H
1957*-P6M
1957-F-8
1957-F11F
1957-HUS
1957-HUL
1957-HR2S
1958*-F8U-3
1958*-T-40
1958-HUK
1959*-P6M
1959-E-1
1960-E-4
1961-A-5
1961-HSS-2/SH-3 A/D
1961-F-4
1962-HU2K
1962-P-3
1963*-A2J-1
1963-A-6
1963-H-50
1963-RA-5C
1963-S-2E
1963 DASH Drone
1964-E-2
1964-CH-46
1964-H-1
1965-EA6A
1965-RF4B
1966-CH-53
1966-A-7
1966-C-2A (COD)
1966-P3B
1967-Trim (AP2H)
1967-F4J
1968*-F111B
1968-OV-10
1968-A6B
1971-CH53A Minesweeping Helo
1971-RH-3A Minesweeping Helo
1972-F-14

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WEAPONS

1951*-GREBE
1954*-METEOR
1955*-Dove
1957*-PETREL
1958-TALOS
1958-Nuclear Bomb B28
1959*-Hi Energy Baron
1959-MK 44 Torpedo
1961-Tartar
1961-Homing Terrier (HT)
1961*-Eagle
1962-Polaris A2
1964-Polaris A3
1964-MK 57 Mine
1965-SADEYE
1965-Destructor MK 115
1966-SUBROC
1967-Destructor MK 36
1968-Talos ARM
1968-538 IR Fuze
1969-Basic Point Defense Surface Missile System
1971-Poseidon
1972-Phoenix

1953*-Oriole
1954-MK 43 Torpedo
1956-Sidewinder 1
1957-LULU
1958*-Sparrow I
1958*-Regulus II
1959-Bullpup A
1960-Polaris A1
1961-Nuclear Bomb B43
1961-MK 55 Mine
1962-MK 45 Torpedo (ASTOR) & MKX 44
1963-TARTAR IT
1964-Bullpup B
1964*-Typhon
1965-Sparrow III (AIM 7-E)
1966-Mine MK 56
1967-Weteye
1968-Standard ARM
1968-Helo Trap Weapon
1968-Destructor MK 40
1969-Standard Missile
1972*-AGILE

1954-Regulus I
1955-Betty
1957*-Sparrow II
1957*-Triton
1958-Nuclear ASW Depth Bomb W-34
1959*-NRRS Sugar Grove
1959-MK 37 Torpedo
1960*-Corvus
1961-MK 52 Mine
1961-ASROC with MK 44 Torpedo
1962-Nuclear ASROC W-34
1963-Nuclear ASW Depth Bomb B57
1964-SHRIKE
1965-Terrier
1965-Sidewinder IC
1966-MK 46 Torpedo
1967-Walleye
1968-5"/38 Rocket Assist Projectile
1968-Rockeye II
1968-Nuclear Bomb B61
1969 Snakeye
1972-MK 48-1 Torpedo

OTHER SYSTEMS

1956-BQS-4 Sonar System
1958-S5W Submarine Nuclear Propulsion Plant
1958-SSQ-23A JULIE Sonobuoy
1959-JEZEBEL/JULIE/Improved MAD
1959-C4G Submarine Nuclear Propulsion Plant (2 Reactors)
1960-MK113 SS Fire Control System
1960-SQS-23 Sonar
1961-APQ-72 Fire Control System
1961-A2W Large Ship Nuclear Propulsion Plant (8 Reactors)
1962-SQQ-14 Sonar
1962-D2G DD Type Nuclear Propulsion Plant
1962-ALQ-51 Airborne Deception Jammers
1963-TACAMO
1963-BQG-2/4 Puffs Sonar
1964-SPS-42 Radar
1965-Airborne Tactical Data System (ATDS)
1965-Type 15 Periscope
1965-SSQ-38A and SSQ-48 Sonobuoys
1966-Marine Tactical Data System
1966-SOLRAD Satellite
1966-Bulleye System HF/DF
1967-Satellite Communication System
1967-Automatic Carrier Landing System
1967-AWG-10 Fire Control System
1967-APR 25 & 27 Airborne Missile Launch Warning System

1958-Nuclear ASW Depth Bomb W34
1958-FPS-16 Radar System
1958-WRT-2 Single Side Band Transmitter
1959-WRL-1 Countermeasures Receiving Set
1960-SIC Submarine Nuclear Propulsion Plant (Turbo-Electric)
1960-SSQ-28 Sonobuoy
1961-SPS-32 and 33 Radar
1961-C1W Large Ship Nuclear Propulsion Plan (2 Reactors)
1961-FPQ-6 and TPQ-18 Radar Systems
1962-BQS-8 Sonar
1962-ULQ-6 Ship Deception Jammer
1963-Navy Tactical Data System
1963-MPS-25 Radar System
1963-SQS-26 Sonar
1964-Towed Fish (Deep Ocean Search Equipment)
1965-SSQ-47 Active Sonobuoy
1965-AWS-13 Sonar
1965-SSQ-41A and SSQ-47 Sonobuoy
1966-SPS-48 Radar
1966-SLQ-12 Jammer
1966-CHECKROTE RADAR SYSTEM
1967-Curv II
1967-Navy Space Surveillance System (NAVSPASUR)
1967-MSD Drone Boat
1967-BQS-8

OTHER SYSTEMS (CONT.)

1968-Navy Navigational Satellite
1968-SPS 54 & 55 Radars
1968-Type 16 Periscope
1968-New Jersey EW Reactive System
1968-ALQ-100 Airborne Deception Jammers
1969-MK 103 Airborne Mine Sweeping Gear
1969-A6 A Radar Beacon Forward Air Controller
1969-SQS-35 IVDS Sonar
1969 Beartrap (Deleted) System
1970-Threat Reactive EW System
1970-ANEW ASW Avionics System (P-3C Aircraft)
1970-APS-81 MAD
1970-VPTSC
1970-WLR-8 Intercept Receiver
1970-SSQ-53 DIFAR Sonobuoy
1971-Shipboard Satellite Read and Equipment (SROE)
1971-BSQ-3 Intrepid
1971-BLR-10 ESM System
1971-BQG-15 Radar
1971-Dixie
1972-BQH-4
1972-MK 30 Mobile ASW Target
1972-AN/SPS 58 Radar
1968-Aims MK X11 IFF System
1968-ASW Ship Command & Control System
1968-Igloo White System
1968-APR-30 Airborne Missile Launch Warning System
1969-AWS-14 Sonar
1969-S5G Submarine Nuclear Propulsion Plant
1969-BQS 11, 12 & 13 Sonar
1969-Omega Navigational System
1970-SQS-38 Sonar
1970-Helo Decoy System
1970-DIFAR
1970-APS-115 Radar
1970-WLR-6 ESM System
1970-SQR-14
1970-BQR-19 Sonar
1971-MK 105 Airborne Minesweeping Gear
1971-BRD 7 Radio D/F System
1971-SRN-9 Satellite Navigation System
1971-ITASS
1971-MK 27 Target
172-BNU-1 Buoy (Deleted)
1972-WLR-9 Sonar Intercept Receiver
1973-BQR-15 Sonar

SOURCE: NAVAL AIR SYSTEMS COMMAND, *UNITED STATE NAVAL AVIATION 1910-1970* (WASHINGTON, D.C., 1970), NAVAIR 00-80P-1, PP. 301-333; U.S. CONGRESS, SENATE, COMMITTEE ON APPROPRIATIONS, *DEPARTMENT OF DEFENSE APPROPRIATIONS HEARINGS*, 93RD CONGRESS, 1ST SESSION, 1973, PP. 958-960.

APPENDIX E

ACCOMPLISHMENTS OF NAVAL RESEARCH

Since Naval Research was directed primarily toward increasing fundamental knowledge, many of its contributions were merged in the totality of the scientific literature and are impossible to identify explicitly. Nevertheless, the following examples of research accomplishments provide some insight into the productivity of this category of effort over the years.

- The support of early fundamental work on shock tubes and shock dynamics was the direct forerunner of the use of shock tubes in the study of re-entry problems and the development of practical nose cone material. It is a primary example of a basic research tool that, through remarkable prescience, was ready to be applied to testing and development programs when needed, even though nobody had conceived the ICBM when the work was first supported.

- The fundamental work on stability of propagation of very low-frequency radio waves over long distances and on atomic time and frequency standards required to make accurate phase measurements was essential to the development of the Omega Navigation system. The atomic standards have allowed accurate control of communications applied in development of the NAVSTAR positioning system.

- Early support of work in Bayesian statistical analysis proved to be of great value as more sophisticated methods of detection of signals in noise became increasingly important in radar and sonar.

- The development of the mathematical theory of diffraction and scattering of electromagnetic waves from large obstacles later became very important in application to the problem of minimum radar return from missiles and decoys.

- Many of the high power sources of electromagnetic energy for Navy and other military radars are sealed klystrons. These klystrons were first designed, constructed, and proven in application to acceleration of electrons to high energies. A program of electron tube research and development, carried out by the same group that developed the klystrons, also led to the eventual development of a large family of traveling wave tubes and backward wave oscillators for high- and low-power applications. These tubes have been used in electronic warfare, radar, and communications systems.

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- Development of the technology of process fluid lubrication, specifically, gas bearings, was supported, and probably more importantly, coordinated by ONR. This work has been essential to development of the gyroscopes used in inertial navigation systems and in design of high-speed tape transports and flying heads for computer disc memories.

- Initial efforts on the electrostatic gyroscope, in which the rotating element is levitated by electrostatic forces, were supported by ONR. This gyroscope was later developed and met expectations of extremely small drift rates. It is being incorporated into the most advanced inertial navigation systems in submarines and missiles.

- Many of the essential features of modern command and control technology originated in early work on the Whirlwind digital computer, associated input-output devices, and software and displays, initiated by ONR. The Air Force accelerated this effort to develop the SAGE system. This technology was then used during the LAMPLIGHT summer study to prove that the NTDS concept could actually work. The ferrite cores widely used in computer memory systems were developed in this same effort.

- The technology of titanium, in particular the thermochemistry of titanium and its alloys, was systematically organized for the first time under ONR auspices. A similar effort was made for the metallurgy of molybdenum and its high-temperature alloys. Titanium has proved essential for the development of high-performance aircraft and for missile structures, and molybdenum alloys for the guidance vanes of Polaris missiles.

- Missile propellants with required physical and ballistic properties were obtained in a sustained program of research and development of nitropolymer solid propellant materials and chemistry managed by ONR. Propellants used in the Polaris A-3, Tartar, and Hawk missiles were developed through this effort.

- Support of fundamental work on the theory of wind-generated waves led eventually to operationally useful techniques for forecasting ocean waves.

- The discovery of microplankton in the oceans led to the realization of the importance of small organisms in affecting acoustic propagation and scattering in the ocean medium.

- The support of fundamental work in oceanic geophysics led directly to the development of a useful geophysical navigation technique.

- Navy interest in towed arrays originated with an ONR program to improve characteristics of commercial geophysical arrays. This early interest centered on development of a mobile measurement system to characterize the radiated noise field of U.S. submarines. This effort was extended to surface-ship towed arrays and developed the underlying technology of all operational towed arrays, including STASS, AN/BQR 15, AN/SQR 15, and AN/BQH 4.

- The existence of a deep sound propagation channel was discovered as an outgrowth of fundamental oceanographic investigations supported by ONR. Applications were made to systems involving long-range sound propagation such as the missile impact location system, the SOFAR system, and the SOSUS surveillance system.

- ONR supported design, construction, test, and use of the deep-submergence research vehicle ALVIN. This vehicle was useful in a number of tasks involving inspection of Navy undersea R&D installations and systems, including ARTEMIS and AUTEC. It proved essential to the finding and recovery of the H-bomb lost in several thousand feet of water off the Spanish Mediterranean Coast.

- Support of the earliest work on numerical modeling of the atmosphere pointed the way toward a practical method of numerical weather forecasting.

- ONR supported research on permafrost, pedology, and geomorphology of the Arctic tundra. This provided essential data required for engineering and construction in that region, specifically for the DEW line. The same program provided mapping of the Barrow canyon, the only route for wintertime, under-ice transits by submarine between the Bering Strait and the Arctic Ocean.

- The initial discovery of the Van Allen belt and the support of a research satellite to measure long-duration properties of the radiation trapped in the belt occurred under ONR programs. The satellite provided essential information with which to make timely assessment of the effects of the STARFISH nuclear explosion when this unexpectedly became an issue of national importance.

- Responding initially to a request from the Polaris program office, ONR supported research under which a military "essentiality coding technique" was found which permitted assessment of the worth of all part candidates for shiploading based on the probabilities of mission completion or abort associated with lack of the part. The work was extended to the economics of the provisioning process. These techniques were used by the Polaris program, and more recently by the F-14 program.

- The data content of the military maintenance management system, the so-called 3M system, was defined and then reduced to a manageable 10 crucial elements in an effort supported by ONR. The work continued to design management outputs over the total user community, and to develop computer software for processing and analyzing data which were essential to the operation of the system.

- A sustained research effort under ONR sponsorship led to the development of a method for rapid freezing, convenient refrigerated storage, and rapid thawing of blood. The technique allowed blood to be stored for periods up to a year rather than the 3 weeks for usual preservation methods. Frozen blood banks of this type were used successfully in Viet Nam. The technique was also adopted by New York City for the storage of rare blood types.

- The development of the plastic cornea for eye repair is an example of assiduous and inspired followup on an initially fortuitous observation.

- ONR sponsored the first nationwide systematic information exchange exclusively devoted to research in computer-aided instruction (CAI), the use of the computer in an on-line, interactive tutorial mode. This exchange kept the DOD and outside communities informed and sparked the growth of related research across the services. Based largely on initial ONR support of CAI research at the U.S. Naval Academy, Annapolis, CAI became an integral part of that institution's regular degree granting program.

- American military equipment has been characterized as significantly better, from the human engineering point of view, than that of other nations by individuals in a position to make comparisons. This was due largely to a sustained program of effort supported by ONR that led to human performance guidelines for design of a variety of systems and sparked establishment of related groups in the Navy and other service R&D communities. To facilitate application efforts, a *Tri-Service Human Engineering Guide to Equipment Design* was prepared and updated periodically.

- ONR supported a sustained research effort to improve organizational development and management practices. Part of this effort led to establishment at the University of Michigan of The Institute for Social Research, acknowledged to be a major national resource in matters relating to the human component of organizations. The Navy experienced considerable direct benefit from such work, particularly in the design and operation of the Navy Human Goals Program.

Sources: Material provided by the Office of Naval Research; James Peneck et al., *The Politics of American Science* (Cambridge, Mass., 1972), pp. 123-125.

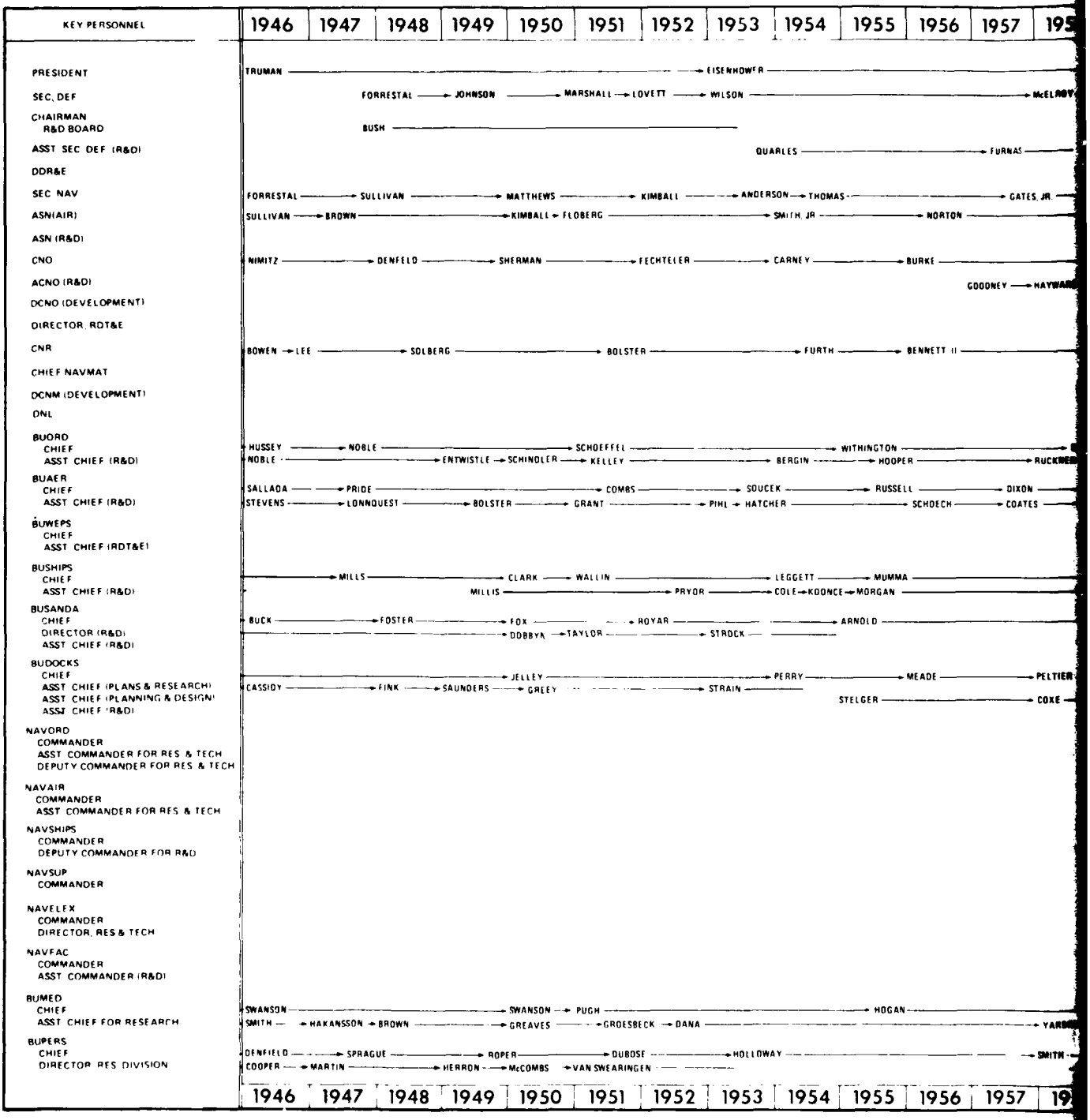
APPENDIX F

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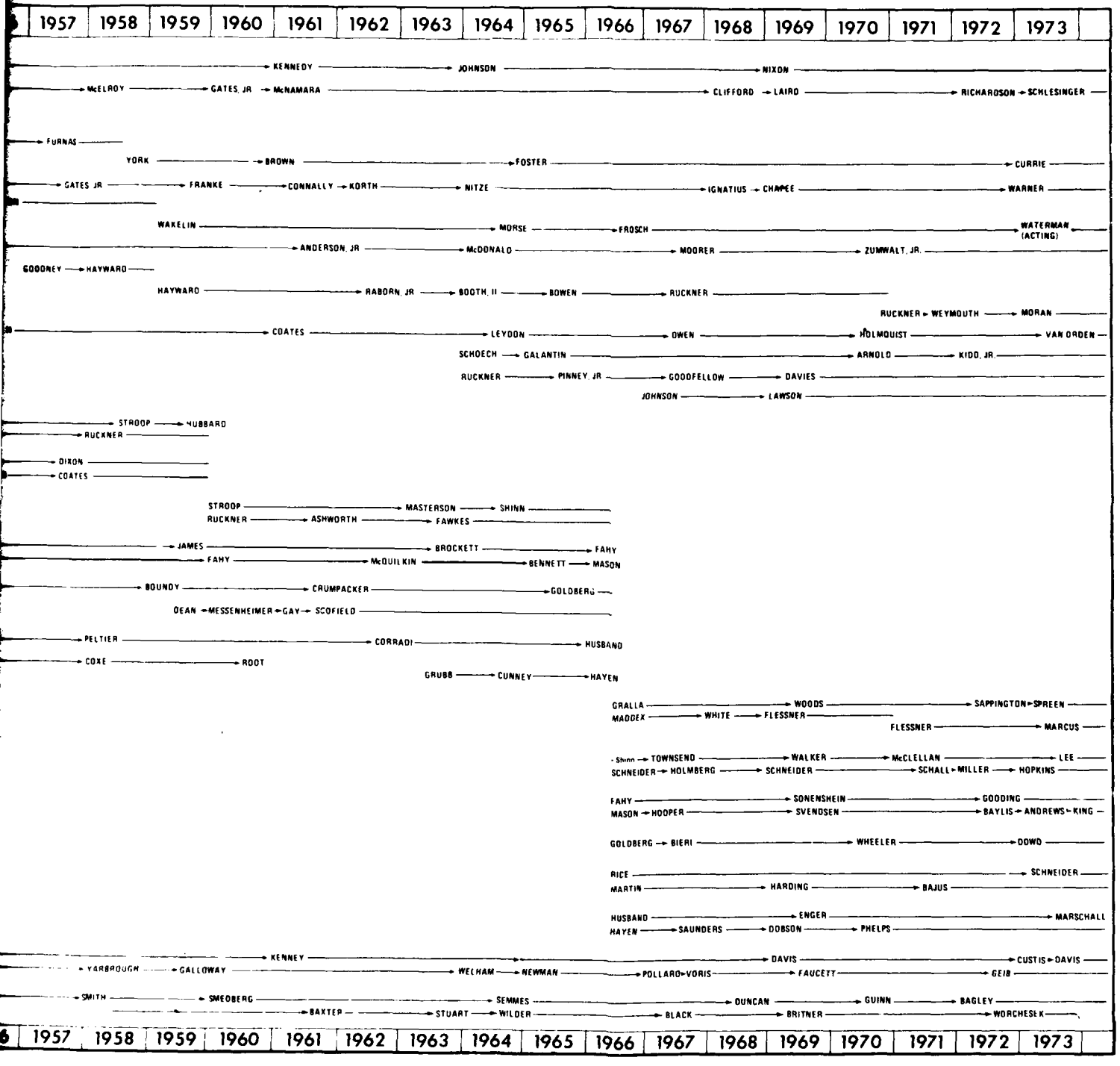
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APPENDIX G

PERSONNEL 1946-1973



APPENDIX H

GLOSSARY

AAW	Anti-air Warfare
ACEL	Aerospace Crew Equipment Laboratory
ACNO	Assistant Chief of Naval Operations
ACP	Area Coordinating Paper
ADO	Advanced Development Objective
AE	Applications Engineering
AEDO	Aeronautical Engineering Duty Officer
AML	Aeronautical Materials Laboratory
ANREP	Appraisal of the Navy Research and Engineering Program
APL	Applied Physics Laboratory
ARPA	Advanced Research Projects Agency
ASD	Assistant Secretary of Defense
ASL	Aeronautical Structures Laboratory
ASN	Assistant Secretary of the Navy
ASPR	Armed Services Procurement Regulations
ASW	Antisubmarine Warfare
BuAer	Bureau of Aeronautics
BuBud	Bureau of the Budget
BuOrd	Bureau of Ordnance
BuShips	Bureau of Ships
BuWeps	Bureau of Naval Weapons
CAB	Chief of Naval Operations Advisory Board
CD	Contract Definition
CEB	Chief of Naval Operations Executive Board
CEC	Construction Engineering Corps
CF	Concept Formulation
CFY	Current Fiscal Year
CND	Chief of Naval Development
CNM	Chief of Naval Material
CNO	Chief of Naval Operations
CNR	Chief of Naval Research
COMINCH	Commander in Chief, U.S. Fleet [(WWII)]
CPAM	CNO Program Analysis Memoranda
CPPG	CNO Policy and Planning Guidance
D&F	Determination and Findings
DCNM	Deputy Chief of Naval Material
DCNO	Deputy Chief of Naval Operations
DCP	Development Concept Paper
DDC	Defense Documentation Center
DDR&E	Director of Defense Research and Engineering
DECOR	Defense Committee on Research
DLF	Direct Laboratory Funding
DLP	Director of Laboratory Programs
DNL	Director of Navy Laboratories
DOD	Department of Defense
DON	Department of Navy
DPPG	Defense Policy and Programming Guidance
DSARC	Defense Systems Acquisition Review Council
DTMB	David Taylor Model Basin
EDG	Exploratory Development Goal
EDO	Engineering Duty Officer
EDR	Exploratory Development Requirement

FCRC	Federal Contract Research Center
FYDP	Five Year Defense Plan
GAO	General Accounting Office
GFE	Government-Furnished Equipment
GOR	General Operational Requirement
IED	Independent Exploratory Development
IR	Independent Research
JAC	Joint Advisory Committee
JCS	Joint Chiefs of Staff
JRDB	Joint Research and Development Board
JRDOP	Joint Research and Development Objectives Document
JSOP	Joint Strategic Objectives Plan
MDL	Mine Defense Laboratory
MPE	Monthly Project Evaluation
NADC	Naval Air Development Center
NAEC	Naval Air Engineering Center
NAMDDU	Naval Air Mine Defense Development Unit
NARDIS	Navy Automated Research and Development Information System
NASL	Naval Applied Science Laboratory
NAVAIR	Naval Air Systems Command
NAVCOMPT	Office of Navy Comptroller
NAVELEX	Naval Electronic Systems Command
NAVFAC	Naval Facilities Engineering Command
NAVMAT	Naval Material Command
NAVORD	Naval Ordnance Systems Command
NAVSHIPS	Naval Ship Systems Command
NAVSUP	Naval Supply Systems Command
NCCCLC	Naval Command Control Communications Laboratory Center
NCSL	Naval Coastal Systems Laboratory
NDRC	National Defense Research Council
NEL	Naval Electronics Laboratory
NELC	Naval Electronics Laboratory Center
NIF	Navy Industrial Funding
NMC	Naval Material Command
NMEL	Naval Marine Engineering Laboratory
NMSE	Naval Material Support Establishment
NOA	New Obligation Authority
NOL	Naval Ordnance Laboratory
NOS	Naval Ordnance Station
NOTS	Naval Ordnance Test Station
NRDL	Naval Radiological Defense Laboratory
NRDRB	Navy Research and Development Review Board
NRL	Naval Research Laboratory
NRR	Naval Research Requirement
NSA	National Security Act
NSRDC	Naval Ship Research and Development Center
NSSNF	Naval Strategic Systems Navigation Facility
NSWC	Naval Surface Weapons Center
NTDS	Naval Tactical Data System
NUC	Naval Undersea Center
NURDC	Naval Undersea Research and Development Center
NUSC	Naval Underwater Systems Center
NUSL	Naval Underwater Sound Laboratory
NUWC	Naval Undersea Warfare Center
NUWRES	Naval Underwater Weapons Research and Engineering Station
NWC	Naval Weapons Center

NWL	Naval Weapons Laboratory
OEDO	Ordnance Engineering Duty Officer
OIR	Office of Industrial Relations
OMB	Office of Management and Budget
ONM	Office of Naval Material
ONR	Office of Naval Research
OPDEVFOR	Operational Development Force
OPNAV	Office of the Chief of Naval Operations
OPTEVFOR	Operational Test and Evaluation Force
OR&I	Office of Research and Inventions
OSD	Office of the Secretary of Defense
OSRD	Office of Scientific Research and Development
PBD	Program Budget Decision
PCP	Program Change Proposal
PDM	Program Decision Memorandum
PDP	Program Definition Phase
PEA	Program Element Administrator
PERT	Program Evaluation and Review Technique
PO	Planning Objective
POM	Program Objective Memorandum
POAN	Procurement of Aircraft, Navy
PPBS	Planning, Programming and Budgeting System
PSAC	President's Science Advisory Committee
PTA	Proposed Technical Approach
RAN	Request for Authority to Negotiate
R&D	Research and Development
RDB	Research and Development Board
RDT&E	Research, Development, Test and Evaluation
RMS	Resource Management Systems
SECDEF	Secretary of Defense
SECNAV	Office of the Secretary of the Navy
SMEADO	Selected Major Exploratory and Advanced Development Objectives
SOR	Specific Operational Requirement
SPO	Special Projects Office
SUBROC	Submarine Rocket [Systems]
SYSCOM	Systems Command
TAP	Task Area Plan
TCP	Technology Coordinating Papers
TDP	Technical Development Plan
TSOE	Tentative Specific Operational Requirement
USNUSL	United States Navy Underwater Sound Laboratory
VCNO	Vice Chief of Naval Operations

APPENDIX I

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