Observations On The Planning Of Research And Exploratory Development

B-164912

Department of Defense

UNITED STATES
GENERAL ACCOUNTING OFFICE

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

PROCUREMENT AND SYSTEMS
ACQUISITION DIVISION

B-164912

The Honorable
The Secretary of Defense

Attention: Assistant Secretary of Defense
(Comptroller)

Dear Mr. Secretary:

On November 20, 1970, we advised you that we were initiating a review of planning and coordinating of behavioral and social science research within the Department of Defense under Code 86609. On February 5, 1971, we informed you that we were broadening the scope of this review to focus more on the military services' overall planning and coordination of research and exploratory development.

The following comments summarize our general observations. These observations, presented in chapter format, are attached as an appendix to this letter for your review and comment. We expect to use this information in planning future audit efforts.

Research and exploratory development provide technical knowledge from which future military weapons and equipment emerge. More specifically, these scientific phases generate the technical know-how to improve operational capabilities, to provide them at lower cost, and to understand and to protect against technological developments of potential adversaries.

The Congress has frequently expressed interest in whether the Department of Defense is spending its research and development dollars where the dollars will obtain the greatest return in increased capabilities. As resources continue to be limited and as the Soviet Union continues to challenge our technological leadership, the Department's use of its limited resources to advance the technological base will continue to attract congressional attention and concern.

Because of the importance of the technology base and because of congressional interest in this area, we studied the military services' policies, procedures, and practices for planning their research and exploratory development work. Because the planning processes are informal and subjective, we were primarily concerned with whether the decisions constituting the planning processes were being made deliberately, rationally, and systematically by the people best qualified to make them.

In general, scientists in the laboratories and scientific program officers or directors in the producing commands plan, develop, and conduct their own research programs. Mission guidance given to these planners is in the form of budgetary constraints and broad operational requirements necessitating considerable interpretation and supplementation. Consequently, scientific planners subjectively integrate many diverse informational sources in order to interpret future operational requirements.

Planning for exploratory development appears to be more systematic than planning for research, with various levels of management within the services' producing commands more actively participating. Generally, the planning includes appraisal and review processes which attempt to rank and weigh the various program elements on the basis of subjective judgments of military utility, time of need, technical feasibility, and other qualitative factors.

To help planners, several quantitative methodologies have been designed and tested for allocating resources to exploratory development projects. The services have concluded, however, that these methodologies are not satisfactory primarily because they attempt to quantify too many uncertain factors.

The major problem in planning for exploratory development seems to be that the numerous projects are difficult to compare with one another although they compete for the same limited resources. Reportedly, Defense officials believe that there is not enough "real information" available to insure that exploratory development money is spent wisely.

Efforts to assist planners, nevertheless, are continuing. Technology coordinating papers are now being developed to bring together in a coherent fashion the exploratory development goals of the services in given technological fields. These documents are expected to help planners spot duplicate, underfunded, and missing programs. The coordinating papers, however, are not decision papers and do not deal explicitly with many uncertainties involved in identifying and assessing research and exploratory development opportunities.

We believe that because the planning processes are informal and subjective, the services should develop procedures to systematically identify and consider (1) decision criteria and objectives, (2) available alternatives, (3) treatment of uncertainties, and (4) the assumptions and value judgments involved.

To avoid excessive compartmentalization, long-range operations planners and intelligence specialists should participate more directly with the research and development communities in planning development of the technological base. In our opinion, operations planners and intelligence specialists should project, interpret, and assess threats and attendant operational requirements in a manner more meaningful to the scientific and technical planners.

We would appreciate your comments and advice on the observations discussed above and elaborated upon in the appendix, and more specifically, on the progress being made to better allocate resources in research and exploratory development. If you or your representatives wish to discuss these matters or require additional information, please contact Mr. Harold H. Rubin, Deputy Director, Code 129, extension 4325.

Copies of this report are being sent today to the Director of Defense Research and Engineering and the Secretaries of the Army, Navy, and Air Force.

Sincerely yours,

R.W. Gutmann

Director

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APPENDIX

ABBREVIATIONS

ARPA	Advanced Research Projects Agency
DDR&E	Director of Defense Research and Engineering
DOD	Department of Defense
GAO	General Accounting Office
JRDOD	Joint Research and Development Objectives Document
ODDR&E	Office of the Director of Defense Research and Engineering
OSD	Office of the Secretary of Defense
R&D	Research and Development
RDT&E	Research, Development, Testing and Evaluation
TCP	Technology Coordinating Paper

CHAPTER 1

INTRODUCTION

The General Accounting Office (GAO) studied the military services' policies, procedures, and practices for planning research and exploratory development programs.

In general, research and exploratory development activities are the scientific processes for developing new technologies that, when carried forward into advanced development, engineering development, and/or operational systems development, improve operational capabilities, provide them at lower cost, and/or provide the technological base to understand and protect against technological developments of potential adversaries. In this sense, research and exploratory development activities are, or should be, mission-oriented or specialized.

RESEARCH AND EXPLORATORY DEVELOPMENT

Research is scientific study and experimentation to increase the knowledge of science. The investigator's primary aim is further knowledge or understanding of the subject being studied. The Department of Defense (DOD) research program is broken down into the following scientific disciplines or categories:

1. General physics.
2. Nuclear physics (Navy and Army only).
3. Chemistry.
4. Mathematical sciences.
5. Missiles (Army only).
6. Electronics.
7. Materials.
8. Mechanics.
9. Energy conversion.
10. Oceanography (Navy only).
11. Terrestrial sciences.
12. Atmospheric sciences.
13. Astronomy and astrophysics.
14. Biological and medical sciences.
15. Behavioral and social sciences.

Exploratory development is that phase between research and advanced development[1] that provides the technological building blocks for improved and/or new military systems. It includes all efforts to solve specific military problems, short of actually developing hardware or processes; its purpose is to develop and evaluate the technical feasibility of proposed solutions and to determine their parameters. This effort may vary from fairly fundamental applied research to quite sophisticated breadboard hardware; it may also include sophisticated study, programing, and planning.

The purpose of research is to increase our basic understanding of natural phenomena from which new ideas for military hardware may be generated. The purpose of exploratory development is to determine the feasibility of utilizing this basic understanding to solve specific military problems; broadly stated, its end product is the determination of the feasibility of concepts and the understanding of engineering characteristics to intelligently decide whether to proceed with developing the military hardware or processes.

Together, research and exploratory development programs establish the "technological base" to improve existing weapons systems and to develop new systems. The U.S. military capability in 10, 20, and 30 years depends significantly on present research and exploratory development work.

FUNDING TO DEVELOP TECHNOLOGICAL BASE

About 25 percent of the total Research, Development, Testing and Evaluation (RDT&E) appropriation is expended to develop the technological base. The remaining 75 percent is expended in advanced development, engineering development, and operational systems development.

Unlike the other RDT&E categories, research and exploratory development categories are funded on a level-of-effort basis, meaning that funds are justified on the basis of maintaining a level of effort (stability of effort) as opposed to being justified on a project-by-project basis.

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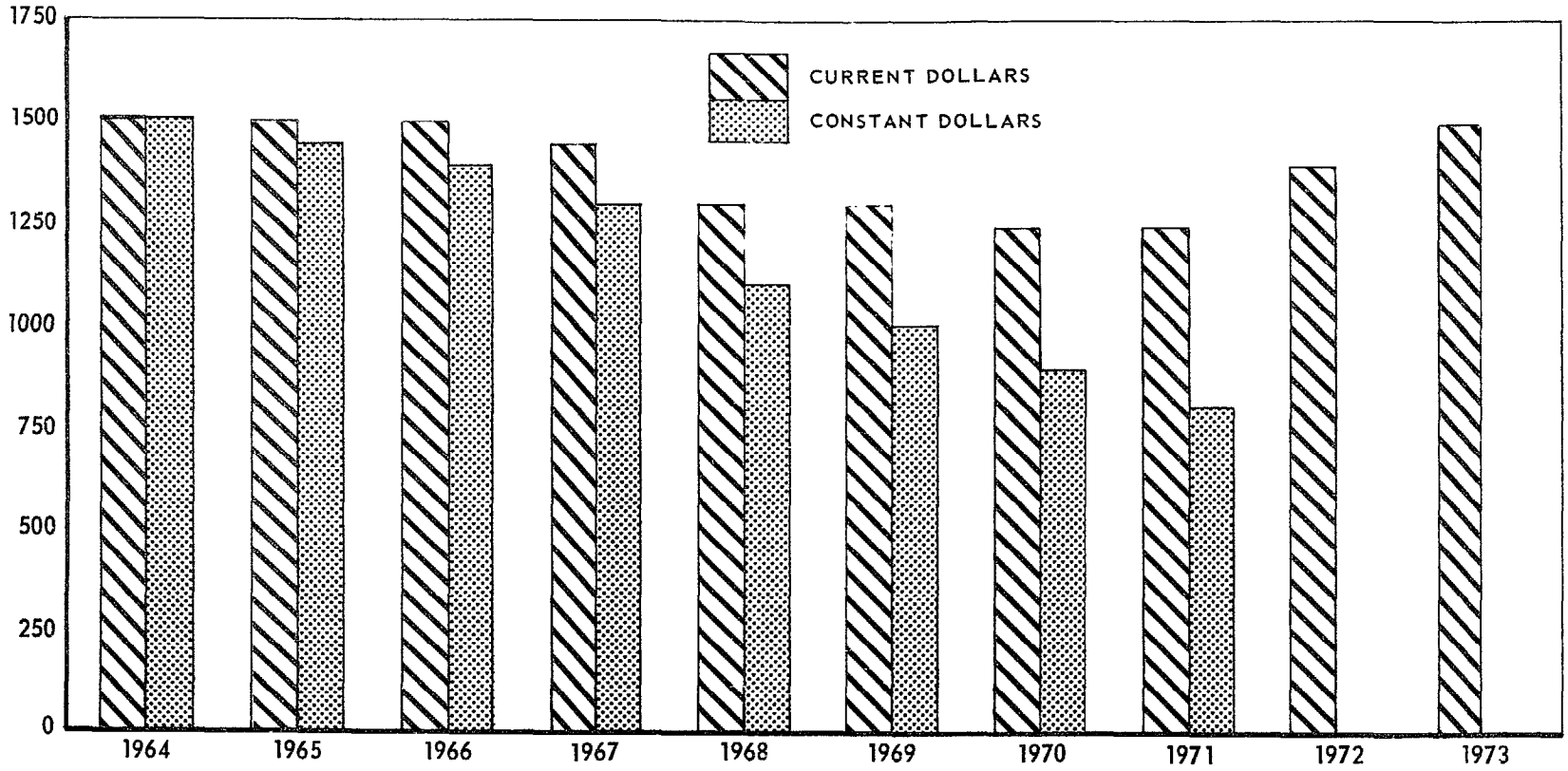
[1] Advanced development includes all projects that have moved into the development of hardware for experimental testing.

As illustrated by figure 1, however, the funds provided to maintain the level of effort decreased about 18 percent from fiscal years 1964 to 1971. Because of inflation, the technical effort which a dollar could purchase also decreased during the 8-year period. Consequently, as expressed in constant dollars, DOD's funding for research and exploratory development actually decreased about 46 percent from fiscal years 1964 to 1971. This trend was being revised in fiscal years 1972 and 1973.

SUMMARY OF DOD FUNDING FOR RESEARCH AND EXPLORATORY DEVELOPMENT
(TOTAL OBLIGATION AUTHORITY)

(DOLLARS IN MILLIONS)



SOURCES: *1964–1968: DEPARTMENT OF DEFENSE APPROPRIATIONS, 1969. HOUSE COMMITTEE ON APPROPRIATIONS PART 2 p. 504*
1969: DEPARTMENT OF DEFENSE APPROPRIATIONS FOR 1971. HOUSE COMMITTEE ON APPROPRIATIONS PART 6 p. 11
1970–1971: DEPARTMENT OF DEFENSE APPROPRIATIONS FOR 1972. HOUSE COMMITTEE ON APPROPRIATIONSPART 6 p. 33
1972–1973: DEPARTMENT OF DEFENSE APPROPRIATIONS FOR 1973. HOUSE COMMITTEE ON APPROPRIATIONS PART 4 p. 783
CONSTANT DOLLARS OBTAINED BY USING AN R& D DEFLATOR DEVELOPED BY DOD BASED ON METHODOLOGY DERIVED FROM " DEFENSE PLANNING IN A HIGH INFLATION ECONOMY ", BY J,H. AUGUSTA AND C.L. SNYDER, JR. PRESENTED AT THE 26TH MILITARY OPERATION RESEARCH SYMPOSIUM, MONTEREY, CALIFORNIA, NOVEMBER 17–19, 1970

CHAPTER 2

PLANNING TO DEVELOP THE TECHNOLOGICAL BASE

THE CHALLENGE

More projects have scientific merit and are technically feasible than can be undertaken with available resources. We believe therefore that anticipated military requirements and utility should also be considered in deciding what research and exploratory development is to be done.

It is difficult, however, to predict military requirements (for new knowledge and technology) for the time frame relevant to current decisions on what research and exploratory development is to be done. A relevant time frame would be from 10 to 30 years in the future. Because of this difficulty, specific military requirements historically have had little influence in allocating resources in the research and exploratory development categories.

CRITERIA AND OBJECTIVES

Predictions about probabilities in 10 to 30 years can never be complete or entirely accurate. Such predictions, however, are implicit in any decision affecting future technological capabilities and options, such as current decisions on what research and exploratory development projects to undertake. The only question is whether the best qualified people are making these predictions and decisions deliberately, rationally, and systematically.

The services generally agree that scientific and technical personnel are best qualified to predict what can be done; military planners are best qualified to predict what is worth doing; intelligence personnel are best qualified to predict what potential adversaries are and will be doing. They also agree that all three groups should work together to (1) define crucial military requirements based on critical assessment of existing and predicted technology and (2) provide military and technical concepts that could serve as the basis for long-range programs in research and exploratory development.

More specifically, the military services agree that, theoretically, their planners should:

1. Identify and define research and exploratory development programs and projects relevant to military needs. Judgments on military needs require weighing what can be done (push of technology) with what is worth doing (pull of operational requirements).

2. Insure that all areas of technology which relate to the military are appropriately identified and considered to avoid technological surprise and unanticipated changes in enemy strategy or policy.

3. Establish priorities that promise the greatest contribution to operational capabilities. This requires weighing factors of military utility, time of need, technical feasibility (risk), and cost.

4. Establish a proper balance between:

   a. Supporting in-house and out-of-house capabilities.

   b. Solving relative near-term technical barrier problems and supporting long-term, high-risk inventive studies.

   c. Generating new technology in accordance with programed objectives and capitalizing on unexpected developments in science and technology.

5. Coordinate research programs and projects within and among military services, defense agencies, contractors, and civil agencies to (1) eliminate unnecessary duplication or overlapping, (2) realign programs and projects to optimize effectiveness of total effort, and (3) more efficiently and economically utilize specialized facilities and other limited resources.

BLUE RIBBON DEFENSE PANEL FINDINGS AND RECOMMENDATIONS

The President and the Secretary of Defense appointed a Blue Ribbon Defense Panel in July 1969, with instructions to

study DOD's entire organization, structure, and operation. The broad scope included DOD's research and development efforts in terms of mission fulfillments, costs, organization, time, and interrelation with the scientific and industrial communities. The panel reported its findings, conclusions, and recommendations in July 1970.

The panel noted that funds for research and exploratory development were appropriated for a level of activity rather than for individual projects like other research and development (R&D) categories. This resulted in several significant shortcomings.

1. Formal requirements from the military operators (users) neither necessitate nor directly affect the allocation of funds in these two categories.

2. Level-of-effort funding requires a much more careful analysis to insure relevancy to military needs than categories controlled on a project-by-project basis.

3. It is much more difficult to detect duplication when funding is on a level-of-effort basis than when specific requirements must be justified and identifiable projects planned and approved as a basis for funding.

4. It requires more intensive review to insure proper allocation of funds so that all parts of the military-relevant spectrum of technology are adequately covered.

5. It is difficult to perform audits to insure that funds are actually used to advance the technological base and not used to supplement efforts to develop specific hardware.

The panel's findings included the following observations:

"There is no adequate or coherent planning for investments in advancing the technological base. Responsibility and management for conducting such research are widely fragmented among and within

> the Military Services and the Defense Agencies. Research funds so allocated have not always been spent on military-relevant technology, nor are all military-relevant areas of technology appropriately considered in the allocation of research funds."

The panel recommended that R&D, to advance the technological base, be a separate program subject to continuing intensive review to insure that all funds are allocated to military-relevant research and that all military-relevant areas of technology are duly considered in fund allocations. The panel recommended, to further improve planning and control over these investments, that the Advanced Research Projects Agency (ARPA) control all work designed to advance the technological base.

CHAPTER 3

PLANNING BY THE OFFICE OF THE SECRETARY OF DEFENSE

Within the Office of the Secretary of Defense (OSD), the Director of Defense Research and Engineering (DDR&E) reviews and directs the research and exploratory development programs; he is the principal scientific and technical advisor to the Secretary of Defense. The Joint Chiefs of Staff act as the principal military advisors to the Secretary of Defense in regard to research and exploratory development matters.

OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING (ODDR&E)

ODDR&E annually reviews the research and exploratory development programs proposed by the services and makes recommendations to the Secretary of Defense. It also provides funding guidance to the services on a level-of-effort basis. ODDR&E, however, does not control the expenditure of funds.

In addition, ODDR&E assigns certain basic and applied research projects to ARPA, which is part of ODDR&E. ARPA administers or performs research work that (1) is not identified with a specific military requirement, (2) relates to the primary functions of two or more services, (3) can be better handled by a DOD agency than by one of the services, and (4) is assigned to it by ODDR&E. ARPA places funded work orders with the military departments or other Defense agencies or places them directly with subordinate activities of the military departments.

Developing technology coordinating papers

In August 1970, the Deputy Secretary of Defense approved ODDR&E's concept for developing technology coordinating papers (TCPs). A TCP is to be prepared for each new field of technology in which DOD supports a major work program, e.g., Missile and Space Vehicles Propulsion Technology and Materials Technology. TCPs are expected to (1) identify the areas most in need of new technology to meet future military system requirements, (2) outline the research and exploratory development programs planned by each service to satisfy

these needs, (3) indicate priorities, (4) reveal unnecessary overlap or duplicate service efforts, and (5) inform managers what new technology to expect and when.

DOD officials estimate that about 11 TCPs will eventually contain perhaps 70 percent of the activities to develop the technological base. By December 1971, two TCPs were completed and approved; nine more are to be completed.

To prepare a TCP, technical experts at the ODDR&E level meet with their counterparts in the services and delineate the issues the TCP is to cover. The services then write their own portions of the TCP. ODDR&E reviews the services' papers, comments on them, requests rewrites when necessary, and combines them into one document.

The TCP process is expected to improve communication among the services in a technology area and to effectively spot duplicate, underfunded, or missing programs. The process, however, is not intended to force multiservice developments which counter individual service desires. According to DOD officials, TCPs are not directives, orders, or decision papers, but rather new tools needed for decisionmaking in technical areas in which decisionmaking has been particularly difficult.

We were advised that the proposed TCPs are not in direct response to the Blue Ribbon Defense Panel's report. However, to the extent that the panel reported that more adequate and coherent planning was needed to advance the technological base, TCPs are expected to satisfy this need.

Consolidating Defense research efforts

The Blue Ribbon Defense Panel stated that responsibilities and management for both research and exploratory development were widely fragmented among the services and the Defense agencies and that this inhibited planning and control of these investments. The panel recommended:

> "The Advanced Research Projects Agency should be delegated the responsibility for all research and exploratory development budget categories. Funds for such research should be budgeted directly to this Agency, and the Agency should be authorized

> to assign or contract for work projects to laboratories of the Defense Department or in the private sector, as appropriate ***."

DDR&E has reported that he would not implement the above recommendation and that the services would continue to manage their own research and exploratory development programs. The Director, however, added that he has consolidated responsibilities for the services' programs designed to advance the technological base under a Deputy Director for Research and Advanced Technology within ODDR&E. The Deputy Director and his staff are to establish overall DOD policy for technological base activities and to review the services' ongoing and planned work within the base.

In addition to the Blue Ribbon Defense Panel, other groups have reviewed the management of these activities over the past several years and have concluded that the services would benefit by consolidating research programs. Similar conclusions, however, were not made about consolidating exploratory development programs.

A Defense Science Board Task Force, in a report entitled "Basic Research Policy of the Department of Defense," dated February 20, 1968, stated:

> "*** It is clear that many of the needs of individual services for basic research are substantially the same; the difference comes in the application of results. ***"
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> * * * * *
>
> "We urge that serious consideration be given to establishing a centrally operated basic research office under the auspices of the ODDR&E. ***"
>
> "The new office would be responsible for maintaining a well-balanced program of relevant basic research, properly weighted to Defense needs. It would address only research, leaving development to the several military departments. ***"

An ODDR&E management analysis report, dated September 15, 1970, entitled "The Defense In-House Laboratories," pointed out the following advantages to having one DOD research organization.

1. High-level attention and support for research programs and a more uniform policy climate.

2. Possibility of a more cohesive program.

3. More effective management of research efforts, free from divisive pressures within the Departments.

4. Superb technical consulting staff to assist DDR&E in program development.

5. Reduced overlapping and duplication of functions.

6. Elimination of interservice competition for resources.

7. Reduction of large intermediate staffs.

8. Streamlined decisionmaking process.

9. Assurance of an improved research environment.

10. Significant savings in funds, manpower, and facilities.

11. Attraction of higher quality people because of the agency's proximity to the policy level.

The report also listed some disadvantages. The most significant disadvantage, in our opinion, would be the separation of research from exploratory development.

TCPs will allow for better planning and feedback to management; TCPs, however, will primarily support exploratory development programs oriented toward specific military applications and technologies.

The three services and the several Defense agencies, however, are all performing research in broad scientific

areas such as chemistry, physics, and social sciences for the same general purpose: to increase knowledge and understanding of the subject being studied. Specific military applications and technologies resulting from this type of research are remote and uncertain.

Our limited analysis of research projects indicated that many of the projects would have Defense-wide or Government-wide application if successful. A prior audit at the Office of Naval Research also showed several instances in which the Navy was conducting basic research in scientific areas in which other agencies had primary responsibility or in which other agencies were known to have extensive research programs.

We recognize that military services are naturally reluctant to relinquish control over their basic research programs. However, in view of the findings of the Blue Ribbon Defense Panel, the 1968 and 1970 studies on the subject, and our limited analysis of research projects, there are persuasive arguments for consolidating the management of all DOD research. However, OSD believes that such a drastic change might be counterproductive unless other difficult changes also are made.

JOINT CHIEFS OF STAFF

The Joint Chiefs of Staff are to advise the Secretary of Defense in research and development matters by preparing statements of (1) broad strategic guidance to be used in preparing an integrated DOD program, (2) overall military requirements, (3) the relative military importance of development activities to meet the unified and specified commanders' needs, and (4) recommendations for assigning specific new weapons to the Armed Forces.

In discharging its duties, the Joint Chiefs of Staff developed a Joint Program for Planning involving the annual preparation of (1) the Joint Strategic Objectives Plan which covers the period from 2 to 8 years in the future, (2) the Joint Long-Range Strategic Study which covers the period 10 to 20 years in the future, and (3) the Joint Research and Development Objectives Document (JRDOD). JRDOD supports the Joint Long-Range Strategic Study and the Joint Strategic

Objectives Plan by translating the broad strategic guidance concerning operational requirements into the research and development objectives and by advising the Secretary of Defense of the military importance of R&D.

Our study was limited to scanning the February 1971 JRDOD. It contained the services' descriptions of their engineering development priorities as opposed to their longer term scientific objectives and priorities. It included the Army's top priority hardware needs, listed as "The Big Eight," for operating in the 1975-80 combat environment.

JRDOD offered the following guidance and direction for research and exploratory development.

1. When the threat remains ambiguous or technical uncertainties preclude commitments to production, R&D programs should receive lower priorities and should be carried only to a level of assurance that would provide a safeguard against technological surprise and unanticipated changes in enemy strategy or policy.

2. There should be a serious effort to determine when equipment improvement has reached the limit of useful evolution so that a timely decision can be made to terminate further efforts in improvement and to orient resources toward new technological approaches to the problem. More innovative investigations which may lead to unexpected results or breakthroughs must be pursued.

3. Systematic and continuing programs of new starts in exploratory development for components and subsystems should be supported as a matter of policy. The more promising new starts should be continued into advanced and engineering development.

Although JRDOD may be useful as a top-level planning document, it is not specific or selective enough to meaningfully direct and guide the military services in planning individual research and exploratory development programs and projects. The services' methods of planning are discussed in the following chapter.

CHAPTER 4

PLANNING BY MILITARY SERVICES

The planning processes for research and exploratory development programs within the services are different, complex, and impossible to fully characterize with simple generalizations. For the purpose of this study, however, certain generalizations are made to characterize the subjective and informal nature of these processes.

PLANNING RESEARCH PROGRAMS

Scientists in the laboratories and scientific program officers or directors in the producing commands plan, develop, and execute the research programs. Guidance given to these planners is in the form of broad mission guidance documents showing operational and material objectives and requirements and anticipated budgetary restraints. Other available guidance sources range from intelligence estimates and strategic studies to informal personal contact networks.

The strategic studies and intelligence estimates, without further elaboration and interpretation, are too general to provide meaningful guidance at the planning and operating levels. The formal operational and material objectives and requirements are not specific or selective enough to enable the scientific planners to evaluate technological needs and priorities. Consequently, program planners generally rely on their informal personal contact networks for guidance. Stated another way, scientific planners subjectively integrate many diverse informational sources in order to interpret future operational requirements.

For example, program directors in the Office of Naval Research receive statements of future operational needs (such as the General Operational Requirements) from the Chief of Naval Operations. Because of the broad nature of this mission guidance, each program director, in developing his portion of the research program, must independently seek out other guidance sources, analyze them, and translate the information obtained into guidance relevant to his decisionmaking needs.

In 1958, ABT Associates, Inc., studied the Office of Naval Research's management procedures and pointed out the need for interface panels to translate broad mission statements into statements of research needs in terms relevant to program directors. A program director advised us in 1971 that statements of operational problems in the language of the research scientist are still needed and that operational requirements need to be more explicit as to what problems are anticipated.

Because scientific personnel make research decisions without adequate or uniform mission guidance, the decisions tend to be heavily weighted with individual considerations for advancing science in general. To illustrate, a major means through which the services carry out their basic research missions is the award of contracts to universities, nonprofit research organizations, and other establishments. These contracts are awarded in response to unsolicited proposals selected essentially on the basis of scientific merit, competence of the investigator, facilities for research, and general relevance to broad service objectives.

In-house research efforts, which are subject to facilities and manpower restraints, are structured around scientific areas that have previously proved beneficial to the military service.

In keeping with the nature of scientific exploration, many people believe the researchers should be left alone to pursue their own goals without direction or interference. Others believe greater emphasis on military utility is needed to reduce the "ivory tower" aspect of some research activities. As stated in chapter 2, we believe that, because more projects have scientific merit than can be undertaken with available resources, decisions on what to study should consider possible military requirements, applications, and utility.

PLANNING EXPLORATORY DEVELOPMENT PROGRAMS

In contrast to research programs, evaluating exploratory development programs appears to be a more systematic process with management more actively participating at the system and commodity command levels.

Because exploratory development is to develop and evaluate technical alternatives for solving high priority military needs or problems, the relevancy and importance of individual projects and tasks are more easily identified and documented. Consequently, the planning generally includes lengthy appraisal and review processes within the producing commands. The planners attempt to informally rank and weigh the various program elements on the basis of subjective judgments of military utility, time of need, technical feasibility, and other qualitative factors.

In addition, DOD and/or service planners designed and tested several quantitative methodologies for allocating scarce resources to exploratory development activities. The proposed methodologies were not considered successful primarily because they attempted to quantify too many uncertain factors. We were advised that one proposed system elaborately tested by the Air Force failed mainly because of its reliance on weighing the importance of Air Force operational requirements and its failure to introduce a factor for uncertainty into its methodology.

In discussing guidance and control of exploratory development projects, an authoritative textbook[1] on the subject states:

> "*** As in all defense programs, exploratory development is controlled in large measure by the resources allocated to it. ***
>
> "Perhaps the single most perplexing problem which managers of exploratory development face involves decisions on allocating resources. They have no clearly defined criteria for making such decisions. The hundreds of different projects which make up this R&D phase defy comparative analysis with one another, yet all compete for limited resources. ***

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[1] Defense Research and Development, National Security Management, Industrial College of the Armed Forces (1968), pp. 97 to 101.

"Defense officials have a deep interest in assuring that exploratory development produces the best results for monies expended. In their opinion, there is not enough 'real information' available to assure that exploratory development money is being spent wisely. In other words, they do not have sufficient information to allow them to make confident judgments on progress in the various disciplines being pursued. The most perplexing question before R&D managers is determining when to shift from 'old dogs' to promising projects. ***

"Because exploratory development, like research, consists primarily of many low-financed projects which laboratories chiefly initiate and manage, it too is funded on a level-of-effort basis. The top echelons of the military services can allocate this fixed resource only among broad scientific fields. It remains for their R&D commands and laboratory directors to divide the money among specific projects. As a result, they have greater opportunity for adjusting the emphasis given to various scientific and technical disciplines related to Service missions."

COMPARING PLANNING PROCESSES

Certain significant procedural differences among the three services' planning processes were noted which may benefit the other services if similarily employed.

Documenting rejected proposals

The Air Force Office of Scientific Research requires that unsolicited proposals rejected by the program managers be documented and the reasons for rejection be fully explained. The Army and Navy, however, do not require this documentation. Therefore no formal record is maintained of these rejected proposals.

We believe that documentation of rejected proposals could provide a useful data bank for future reference. For example, future proposals which seem similar to past

proposals could be evaluated with full knowledge of the prior actions taken. In addition, when a new area of interest arises, past proposals which relate to the new area could be reconsidered. This would give decisionmakers a memory capability that they do not now possess.

Coupling research and exploratory development

An appropriate coupling mechanism is needed to insure an adequate and continuing flow of information between research and exploratory development. The Air Force has a formal reporting process involving "research needs" and "research advances." The exploratory development laboratories prepare research needs to identify specific types of research needed to bridge technological gaps and support future programs. The research activities (which generally are separate from the exploratory development laboratories) must formally respond to each research need, identifying current knowledge available in the area, ongoing related work, and planned research which will respond to the need.

Research laboratories prepare research advances to inform the technology laboratories of research results which show promise for continuation as exploratory development. As with research needs, formal responses are required advising research laboratories of the results of technology laboratories' evaluation and any action being taken to exploit these advances.

The Army and Navy do not have formal systems for coupling research and exploratory development. In the Navy the individual program manager must "sell" his research advances to the exploratory development laboratories. In addition, the exploratory development laboratories must informally request the needed research and the research activity is not required to respond to the request.

Where research and exploratory development work is done by the same laboratories, there appears to be less need for a formal reporting process involving research needs and advances in order to promote coupling of research with exploratory development.