Implementation Of 1970 Defense Procurement Authorization Act Requiring Relationship Of Research To Specific Military Functions B-167034

Department of Defense

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

JUNE 23, 1970

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-167034

Dear Senator Mansfield:

This is our report on the review made in accordance with your letter of April 16, 1970. As requested, we reviewed the implementation by the Department of Defense of section 203 of the Defense Procurement Authorization Act, Public Law 91-121, which limits the use of fiscal year 1970 research funds by the Department to only those projects which have a "direct and apparent relationship to a specific military function or operation."

You also inquired concerning the disposition of Government-owned plant and equipment identified with research projects disqualified under section 203. We learned that actual disposition of this equipment was still uncertain. Navy and Air Force officials indicated that they planned to leave the equipment until it was needed elsewhere or until a determination was made that the institutions would not obtain funding from other sources to continue the research. We discussed this matter with members of your staff who agreed that no formal reporting was required.

Your attention is invited to the fact that officials of the Department of Defense, the military departments, and the Defense agencies have not been given an opportunity to formally review and comment on the contents of the report. We believe that the matters discussed in the report would be of interest to these officials. Therefore you may wish to make copies of the report available to them.

We plan to make no further distribution of this report unless copies are specifically requested, and then we shall make distribution only after your agreement has been obtained or public announcement has been made by you concerning the contents of the report.

Sincerely yours,

Elmer B. Staats

Comptroller General
of the United States

The Honorable Mike Mansfield
United States Senate

COMPTROLLER GENERAL'S REPORT TO THE HONORABLE MIKE MANSFIELD UNITED STATES SENATE

IMPLEMENTATION OF 1970 DEFENSE PROCUREMENT AUTHORIZATION ACT REQUIRING RELATIONSHIP OF RESEARCH TO SPECIFIC MILITARY FUNCTIONS

Department of Defense B-167034

D I G E S T

WHY THE REVIEW WAS MADE

The 1970 Defense Procurement Authorization Act, Public Law 91-121, section 203, states that:

> "None of the funds authorized to be appropriated by this Act may be used to carry out any research project or study unless such project or study has a direct and apparent relationship to a specific military function or operation."

To ensure compliance with this limitation, the Deputy Secretary of Defense directed the military services and Department of Defense (DOD) agencies to review all active research projects and to terminate any project not meeting the provisions of section 203. The review was to be completed in March 1970.

In April 1970 Senator Mike Mansfield requested that the General Accounting Office (GAO) examine into the implementation of section 203, particularly as to the

--guidance and specific criteria, if any, furnished to the administrators who made the initial decisions;

--higher echelon reviews made of the initial decisions, especially where lower level decisions were reversed;

--procedures used in carrying out the reviews, noting particularly any differences among the several agencies;

--projects which were disqualified by each of the military services and

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--selected Advanced Research Projects Agency projects, none of which were disqualified.

FINDINGS AND CONCLUSIONS

DOD did not furnish guidance to try to attain uniform application of the Act and made minimal tests of the results of the reviews.

Tear Sheet

JUNE 23, 1970

(See pp. 6 to 11.) The procedures established by each military service and the Advanced Research Projects Agency for reviews of all research projects differed substantially. (See pp. 12 to 29.)

Interpretations of the law differed widely, as shown by numerous reversals by higher echelons of determinations that projects did or did not qualify. For example:

--Of 28 projects, involving fiscal year 1970 funds that had been disqualified by the Army at the field level, 14 were determined by headquarters to qualify. (See p. 15.)

--Conversely, only five of 200 Navy general physics projects were disqualified in the initial reviews but 47 projects were disqualified in the final reviews. (See p. 19.)

The military services determined that 434 basic research projects of about 6,600 reviewed did not comply with the law. Of the 434 projects disqualified, 220 involved fiscal year 1970 funds of $8.8 million (about 2 percent of the $379 million available for research in fiscal year 1970). The total DOD investment in the 220 projects is substantially greater than $8.8 million, however, since research projects generally are funded incrementally over a period of years. For example, 72 projects disqualified by the Air Force--costing $3.9 million in fiscal year 1970--received nearly $19 million in prior years; additional support probably would have been provided for many of these projects in future years if the law had not been enacted. (See pp. 12 and 22.)

Projects were generally disqualified because the problems to be solved were not unique to the military, ~~and~~ because civil agencies had responsibility, or the research was too far removed from actual application to have a direct relationship. For example:

--The Navy disqualified a project funded for 14 years--total $256,000--for research in prevention of dental cavities. The Navy concluded that this research did not meet the direct relationship test because of the short tenure of most naval personnel. (See p. 34.)

--The Army disqualified a project funded for 15 years--total $343,000--for research in mathematical theory not directly relevant to Army needs. (See p. 37.)

--The Air Force disqualified a project funded from 1966--total $230,000--for research on the theory of violent social protest and broad social movements in countries having two different cultures, western and oriental. The Air Force concluded that this was more relevant to the mission of the Department of State. (See p. 34.)

--The Air Force decided to cancel support of 26 nuclear physics research projects costing $12 million because the research was not

oriented toward specific Air Force functions and operations and was more properly a function of the Atomic Energy Commission and the National Aeronautics and Space Administration. (See p. 30.)

--The Navy similarly decided to discontinue funding research projects in fundamental physics and elementary particle physics. (See p. 19.)

The Advanced Research Projects Agency review involved fewer levels of examination and a broader interpretation of section 203 than the military services' reviews. None of its projects were disqualified. GAO noted several behavioral science projects which appeared questionable. For example:

--One project involved nearly $9.6 million to develop advanced computer tools and methods for use in conducting behavioral science research. The National Science Foundation is directed by law "to foster and support the development and use of computer and other scientific methods and technologies, primarily for research and education in the sciences." (See p. 27.)

--Another project concerned research on the use and dissemination of foreign area data to develop techniques for forecasting important trends in international security affairs. This project may be more appropriate for the Department of State. (See p. 28.)

OBSERVATIONS

Better and more uniform results could have been achieved had DOD provided the administrators with guidance for applying section 203. Such guidance might have resulted from a more intensive review of the actions taken by the military services and DOD agencies.

GAO believes that, if the policy set forth in section 203 is continued, the Bureau of the Budget and the Office of Science and Technology should assist DOD in providing guidance for applying the policy and in establishing procedures which will obtain better and more uniform results.

GAO notes that the fiscal year 1971 National Science Foundation budget request has been increased to facilitate continued support of projects of high scientific merit no longer funded by DOD and other mission-oriented agencies. GAO believes that such action is desirable in making possible a coordinated and balanced research program.

Tear Sheet

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ABBREVIATIONS

ARPA	Advanced Research Projects Agency
DOD	Department of Defense
GAO	General Accounting Office

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CHAPTER 1

INTRODUCTION

At the request of Senator Mansfield, the General Accounting Office has examined into the review conducted by the Department of Defense to determine whether its research projects comply with section 203 of the 1970 Defense Procurement Authorization Act.

Our examination was directed primarily to determining what guidelines had been established for the screening of the defense research projects and whether any specific criteria on which to base the reviews had been prescribed by DOD or by the military services or DOD agencies. We compared the procedures used by the military services and DOD agencies in carrying out their reviews, to identify any common pattern or reasoning among the services. We interviewed responsible officials relative to criteria and procedures prescribed and followed in screening active research projects or studies, hereinafter referred to as projects, to determine their compliance with the requirements of section 203.

To determine the nature and type of research affected by section 203, we reviewed selected research projects disqualified by the military services under its provisions. We reviewed also selected projects of the Advanced Research Projects Agency (ARPA) which had determined that all its projects qualified under section 203.

The Director of Defense Research and Engineering is the principal advisor to the Secretary of Defense on scientific and technical matters; he supervises and coordinates research and engineering activities in DOD and directs such activities performed by DOD agencies, including ARPA. Each of the military services administers its own research program under the direction of the Assistant Secretary (Research and Development) of each service.

The primary office responsible for establishing policy, plans, and program guidance and for monitoring the research program of each service is as follows:

Army--The Army Research Office, Arlington, Virginia, headed by the Director of Research who is responsible to the Chief of Research and Development.

Navy--The Office of Naval Research, Washington, D.C., headed by the Chief of Naval Research who reports directly to the Assistant Secretary of the Navy.

Air Force--The Office of Aerospace Research, Arlington, Virginia, under the direction of the Commander who is responsible to the Deputy Chief of Staff, Research and Development.

Research programs for each of the services are accomplished in in-house laboratories, development centers, and field stations or through contracts and grants with universities, nonprofit organizations, and industrial laboratories.

CHAPTER 2

EXTENT OF GUIDANCE FOR ACCOMPLISHING THE DOD REVIEW

Guidelines were not established by DOD or the Secretaries of the military departments to try to attain uniform application of section 203. Therefore interpretation of the terms "direct and apparent relationship" and "specific military function or operation" was generally a matter of individual judgment by each reviewer.

OFFICE OF THE SECRETARY OF DEFENSE GUIDANCE

By memorandum of December 2, 1969, the Deputy Secretary of Defense requested the Secretaries of the military departments and the Directors of DOD agencies to ensure that, prior to the approval of any new research project or the continuation, modification, or extension of any existing project, a written statement be furnished by the project manager that describes the research, its purpose, and its direct and apparent relationship to one or more specific military functions or operations. Any project not having a direct and apparent relationship to a specific military function or operation was to be terminated. He requested also that the Director of Defense Research and Engineering work with the Secretaries of the military departments and the Directors of DOD agencies in reviewing current research projects, as well as selection criteria used to evaluate proposed projects.

On December 29, 1969, the Director of Defense Research and Engineering provided the military services and DOD agencies with an outline of the steps to be taken in implementing the provisions of section 203. He pointed out that detailed and clear criteria for application of section 203 had not yet been established. He directed that the review cover all basic research and exploratory development projects, both in-house and contracted. In addition, he requested that a summary statement, in layman's terms, be prepared, for each item, explaining the military purpose of the work.

An official of the Office of the Director of Defense Research and Engineering told us in April 1970 that evaluation of research efforts in the context of section 203 was subject to individual subjective judgment and that, in his opinion, no specific criteria should be established for the application of section 203. Therefore the Director of Defense Research and Engineering left the interpretation of section 203 up to the independent judgment of the military services and DOD agencies.

ARMY GUIDANCE

In January 1970, the Adjutant General of the Army provided Army activities with guidance for implementing section 203. He reiterated DOD guidance and instructed the activities to ensure that the intent and spirit of section 203 were followed. Subsequently, a memorandum was issued from the Office of the Chief of Research and Development to the activities authorized to engage in research, requiring that a statement, in layman's terms, be written for all research efforts, expressing a direct relevance to an Army application, function, or operation. No further explanation or interpretation of the meaning of section 203 was provided. The interpretation of direct and apparent relationship and specific military function or operation was therefore left to the individual judgment of each activity in screening its research projects.

Each of the Army activities involved in research was to establish its own guidelines for reviewing its program for compliance with section 203. We therefore inquired into the guidelines established by one of these activities for conducting its reviews. For this purpose we selected the Army Research Office-Durham, located in Durham, North Carolina, which conducts that portion of the Army's basic research program in mathematics and the physical, engineering, and environmental sciences accomplished through contracts and grants with universities as directed by the Chief of Research and Development.

The Army Research Office-Durham interpreted military functions and relevance as follows:

1. The stipulation that a direct relationship of a research project to a specific military function must be apparent implies that the existence of such a relationship can be explained to a layman in lay terms, as well as to experts in specialized research areas.

2. It has been assumed that military function or operation refers to such military functions as surveillance, target acquisition, night vision, fire power, mobility, logistics, etc.

3. Corresponding operational capabilities of the Army depend on the performance of a great variety of sophisticated devices and equipment. Research which is expected to contribute to the improvement of such material should therefore satisfy the requirement of section 203.

Our review of selected relevance statements written by the Army Research Office-Durham showed that the specific function or operation was generally not identified although identification appeared to have been required by the Deputy Secretary of Defense's letter of December 2, 1969. Instead, the potential application of the research which would contribute to broad areas of military need was stated. For example, the relevance statement on the project called Fluidic Materials and Fabrication Techniques for Military Hardware was stated as follows:

> "To find materials and techniques which will allow fluidic devices to be constructed more economically and be capable of withstanding harsh environments e.g. nuclear radiation and high temperatures, so as to meet a wide range of military hardware needs."

NAVY GUIDANCE

The Secretary of the Navy issued a directive in January 1970 promulgating the Office of the Secretary of Defense's review guidelines but giving no additional guidance for interpreting the provisions of section 203. Earlier, the Office of Naval Research issued instructions that a statement be prepared showing the direct and apparent relationship of each project to a specific military function or operation. The following identification of a specific function or operation was provided for the guidance of Office of Naval Research scientific officers and was incorporated into their research project titles and justification statements.

Surveillance
Command control
Communications
Navigation
Navy vehicle design and construction
Energy conversion
Weaponry
Personnel technology
Navy environment

The Chief of Naval Research informed us that the decision as to whether the project had a direct and apparent relationship to a specific military function or operation was based on the reviewer's subjective judgment. He stated that, in his own evaluation of the research projects, he considered factors such as the state of the art in a particular area of science, the Navy's needs in the area, and the potential contribution of the research to the Navy.

He told us that he had received no detailed guidance from the Assistant Secretary of the Navy (Research and Development) but that he kept the Assistant Secretary advised on the progress of the review.

AIR FORCE GUIDANCE

In December 1969 the Air Force Deputy Chief of Staff, Research and Development, directed the Office of Aerospace Research and the Air Force Systems Command to review all

research projects. To ensure that each project met the requirements of section 203, his instruction provided that a statement be prepared showing the project's direct and apparent relationship to a specific military function or operation. No additional guidance was given, however, for interpreting the provisions of section 203.

In a December 1969 memorandum, the Commander, Office of Aerospace Research, directed all subordinate activities to ensure that, for each research project, there was a relevance statement in the spirit of section 203. The relevance statement was to incorporate (1) identification of the specific Air Force function, (2) a specific statement of the Air Force problem, (3) a description of the research, and (4) a statement showing the impact of the research project on the problem. The memorandum cited the following examples of a function: (1) advanced aerospace vehicles (reconnaissance), (2) nuclear weapons delivery, (3) airborne surveillance, target acquisition.

The Deputy for Laboratories, Office of the Assistant Secretary of the Air Force (Research and Development) told us that, because of the tight schedules for conducting the review, guidance to those involved in the review process was given verbally, rather than in writing. He said that, during the review, exchange of information concerning criteria for the review took place among the various Air Force elements involved and with the Office of the Director of Defense Research and Engineering.

ARPA GUIDANCE

In its guidelines for preparing relevance statements for its research projects, ARPA also did not provide guidance as to the meaning of the terms "direct and apparent relationship" or "specific military function or operation." The program managers were advised orally that relevance statements should contain (1) an explanation of what the work consisted of, (2) the broad problem area of which the project was a part, and (3) the specific potential military application of the work. The Director of ARPA advised us that each of its research projects was required to have at least one military application to qualify it for acceptance as being relevant.

We asked ARPA officials whether the term, "specific military function or operation" had been defined for the purpose of the section 203 review. They stated that it was their view that the function or operation to which a project was relevant was self-defining. By explicitly stating what each piece of work was and what its purpose would be, they felt that the military function to which the project was related would be apparent. For this reason, they did not feel that it was necessary to compile a list of specific, well-defined military functions to serve as a guideline for their reviews. Thus ARPA instructions did not require identification of a specific military function or operation, although such identification seems to be required by the Deputy Secretary of Defense's memorandum of December 2, 1969, as well as by section 203.

OBSERVATIONS

We found no common basis for judging the degree of relevance required by the term "direct and apparent relationship." The lack of guidance as to relevance criteria to be applied uniformly throughout DOD was evidenced during our discussions with officials of the military services. We were told that nearly any research project could be considered relevant to a military mission by use of the proper phrases but that the problem was determining the degree of relevance required by section 203. This determination was left to the individual judgment of the independent reviewers in the military services and DOD agencies.

CHAPTER 3

PROCEDURES FOLLOWED AND RESULTS ACHIEVED IN REVIEW OF RESEARCH FOR RELEVANCE

OFFICE OF THE SECRETARY OF DEFENSE PROCEDURES

The Deputy Director (Research and Technology) of the Office of the Director of Defense Research and Engineering told us that his office relied upon the relevance reviews made by the military services and DOD agencies because it did not have sufficient staff to review all research efforts. He added that, on the basis of limited spot checks, his office concurred in the review results submitted by the services and by DOD agencies.

To comply with section 203, the military services and DOD agencies reviewed about 6,600 basic research projects. Of the projects reviewed 434, or 6.5 percent, were disqualified by the military services because the projects did not meet the provisions of section 203. The DOD agencies (ARPA and the Defense Atomic Support Agency) did not disqualify any projects. The disqualified projects are shown, by field of science, in appendix I.[1]

Fiscal year 1970 funds totaling $8.8 million were associated with 220 of the disqualified projects, about 2 percent of the $379 million of fiscal year 1970 funds available for basic research. Of this amount, about $6.6 million was associated with projects that had already been funded or with in-house research. Plans to obligate the remaining $2.2 million were canceled.

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[1] In addition to these disqualified basic research projects, 13 exploratory development projects totaling $58,000 were disqualified under section 203 provisions. These were Air Force projects involving man-in-space and clinical research programs.

It should be noted that the majority of research projects had been incrementally funded for a number of years--some for more than 10 years. Thus the amount of funds which were planned to be applied to the disqualified projects in 1 year, such as fiscal year 1970, is not a true measure of the total financial significance of the decisions to disqualify the projects.

The Defense Atomic Support Agency reviewed 258 basic research projects and found that they all complied with section 203. In view of the time limitation, we did not examine into the guidance and procedures used by the Defense Atomic Support Agency.

DEPARTMENT OF THE ARMY PROCEDURES AND RESULTS

The Department of the Army's procedures for implementing section 203 called for a review of each research effort by the activity engaged in the research and for a subsequent review of each such effort by the Army Research Office.

According to an official of the Army Research Office, a standard method for accomplishing its review was not specified for each of the Army activities involved; instead each organizational unit was to develop its own review procedures. Our examination was confined to the procedures employed by the Army Research Office-Durham for performing its relevance reviews.

The Army Research Office-Durham did not develop written procedures for its scientific divisions to follow in implementing section 203. Officials of this office prepared a memorandum for us outlining the procedures followed in the section 203 reviews.

1. The Chief Scientist and Deputy Chief Scientist made preliminary surveys of active research projects to determine their relevance to military functions. It was determined that several research projects would not satisfy the requirements of section 203. It was determined also that almost all existing relevance statements would have to be clarified in order to explain in nontechnical terms the direct and

apparent relationship of the research to specific military functions or operations.

2. The scientific divisions were requested by the Chief Scientist to reexamine the scope of each active research project and to rewrite the Army relevance statements in nontechnical terms. The information was to be supported by the Army Research Plan and other official, but unclassified, documents. Also, any comments from Army laboratory scientists concerning the importance of the research to the Army were to be included.

3. Each statement was reviewed by the Chief Scientist. The criteria developed by the Army Research Office-Durham for implementing section 203 (see p. 7) were applied by the Chief Scientist in screening the projects for compliance with military relevance.

On the basis of discussions with the chiefs of three of the seven scientific divisions and a limited review, we believe that the above procedures were followed.

The Office of the Chief Scientist considered 78 of the 487 active research projects (or about 16 percent) to have insufficient military relevance to comply with section 203. Of the 78 projects, 50 involving only fiscal year 1969 or earlier funds were to be terminated when their current support periods expired. The remaining 28 projects involved fiscal year 1970 or later funds which were already obligated or were to be obligated. This information was transmitted to the appropriate Army Research Office divisions responsible for monitoring the Army-wide program for the applicable field of science.

An Army Research Office official informed us that, to ensure future compliance with section 203, statements reflecting the relevance of the proposed research will be included in documentation in procurement requests. Army Research Office officials informed us also that:

1. No Army activity, other than the Army Research Office-Durham, had reported any nonrelevant research.

2. Each research project had been reviewed at the Army Research Office division level. None of the projects which had been considered relevant by lower echelons had been considered nonrelevant in these reviews.

3. On the basis of their reviews, the Army Research Office divisions determined that 14 of the 28 projects involving fiscal year 1970 funds that had been disqualified by the Army Research Office-Durham had complied with section 203. Contracts had been awarded for three of the remaining 14 projects, and it was agreed that these three projects would be continued until the funds provided were exhausted. Planned use of fiscal year 1970 or later funds for the other 11 projects was canceled.

4. After completion of the reviews by the responsible division a panel, consisting of the Deputy and the Scientific Director of the Army Research Office and its division chiefs, made a spot check of prior reviews but made no reversals of prior decisions of the divisions.

The Department of the Army reviewed a total of 1,579 basic research projects and disqualified 64, or 4.1 percent, under section 203.

Of the 64 disqualified projects, 14 involved fiscal year 1970 basic research funds totaling about $371,000. (See app. I for a breakdown of these projects by field of science.)

Reversal of lower level decisions

Upon inquiry into the reasons for reversing the decisions on 14 of the 28 projects involving fiscal year 1970 funds that had been disqualified by lower echelons under section 203, we were informed by Army Research Office officials that relevance was a matter of degree and was subject to individual judgment. They expressed opinions that the Army Research Office-Durham's judgment and interpretation of section 203 had been too strict. We discussed specific examples of reversed disqualifications with Army Research Office officials. In general, their replies were

that the research projects had potential for benefiting the Army's operational capabilities or that the projects were of interest to other Army research activities.

DEPARTMENT OF THE NAVY
PROCEDURES AND RESULTS

In November 1969, the Chief of Naval Research issued instructions to Office of Naval Research personnel requiring that reviews be made of all research project summaries and planning summaries to ensure that the statement of research objective showed a direct and apparent relationship to a specific Navy function or operation. In December 1969, the Chief of Naval Research directed other naval activities administering basic research projects to perform similar reviews.

Following the issuance of directives in December 1969 by the Office of the Secretary of Defense, the Chief of Naval Research established procedures for performing the section 203 review. Each basic research project was to be separately reviewed by six officials of the Office of Naval Research, starting with the responsible defense research sciences subelement monitor and ending with the Chief of Naval Research, each level's decision superseding the prior levels' decisions. In addition, Office of Naval Research officials reviewed all other basic research projects under cognizance of the Navy bureaus, systems commands, and other Navy activities. The detailed instructions provided that each project be classified, according to the reviewer's judgment, in one of the following three categories.

1. The title of the research project or the statement of research objectives did not comply with provisions of section 203 but could be revised to meet the requirement.

2. The title and statement of objectives did not comply and could not be revised to show that the research complied with section 203 requirements.

3. The research met the requirements of section 203.

Under the above procedures, each of the six reviewers was to record his decisions on a work sheet.

The results of the reviews and the recommended actions for disposition of those projects which did not comply with

section 203, were reported to the Assistant Secretary of the Navy (Research and Development). The Chief of Naval Research stated that the Assistant Secretary of the Navy (Research and Development) had reviewed and accepted all final decisions made by the Chief of Naval Research.

So that future compliance with section 203 requirements would be ensured, in November 1969 the Office of Naval Research procedures were amended to require that statements of research objective show direct and apparent relationships to specific military functions or operations. In addition, the Chief of Naval Research established a procedure in February 1970 requiring that all naval activities submit to him for review a basic research project summary of each new, renewal, or modified contract and in-house work assignment.

A total of 2,493 Navy basic research projects were reviewed, and 219, or 8.8 percent, were classified as not complying with section 203. Of the 219 projects, 134 involved fiscal year 1970 basic research funds totaling about $4.6 million.

In a February 1970 memorandum, the Assistant Secretary of the Navy (Research and Development) advised DOD of the proposed disposition of the research projects not complying with section 203. Of the 219 projects, 157 will be allowed to expire under the terms of the current contracts, 48 in-house research projects will not be continued after June 30, 1970, and 14 projects will be terminated at a time mutually convenient to the Navy and to the contractors. These 14 projects involved equipment loans or other nonfunded arrangements which were not associated with obligation of funds.

In addition, in April 1970 the Office of Naval Research reviewed all research planning documents and concluded that research in its fundamental physics program and elementary particle physics program was too broad to meet section 203 requirements. These two programs will be dropped from the Navy's research program, and most research contracts under these programs will be terminated upon expiration of current contracts. The remaining contracts will be transferred to other programs.

Reversal of lower level decisions

Navy records of the reviews made by Office of Naval Research officials showed that in several instances decisions as to whether certain research projects met the criteria of section 203 differed among the six levels of review. We noted that generally the initial two review levels, consisting of scientific officers directly involved in the programs, had disqualified fewer projects than had the top management officials. In a few scientific areas, however, a number of projects disqualified by lower level reviewers had been reinstated by the Chief of Naval Research.

The areas of science where principal differences in the decisions were noted are described below.

In the astronomy and astrophysics program, none of the 31 projects which we reviewed had been disqualified by the first two review levels. Up to 16 of these 31 projects were determined not to be in compliance with section 203 by the next three review levels. The Chief of Naval Research ultimately disqualified 13 of the 31 projects. He told us that apparently the higher level reviewers had not had as much enthusiasm about the projects as could be expected of those directly involved in these projects.

During our review of 200 projects in the general physics program, we noted that 47 projects ultimately had been found to have no direct and apparent relationship to specific Navy functions or operations. Of the 47, only five were placed in this category by the first two review levels. The Chief of Naval Research stated that it was a matter of interpretation where to stop on the continuum of naval relevance in deciding which projects have a direct and apparent relationship. He said that he disqualified those physics projects where the research, in his opinion, was several steps removed from direct naval needs.

In the area of nuclear physics, 29 of the 52 projects were disqualified under section 203; however, only 16 to 20 of the 29 projects had been disqualified at the lower levels. The Chief of Naval Research informed us that he believed that the Navy's nuclear physics program should be oriented toward

control of nuclear fusion on earth, rather than studies of energy sources in the universe, and that his decisions reflected this thinking.

DEPARTMENT OF THE AIR FORCE
PROCEDURES AND RESULTS

In a December 1969 memorandum, the Commander, Office of Aerospace Research, directed that all subordinate activities review each research project summary and rewrite the relevance statement in the spirit of section 203. In December 1969, the Office of Aerospace Research established its plan for reviewing all research projects, which provided for three levels of review by panels or teams.

The first review level consisted of 13 panels, one for each of the Air Force's scientific area subelements, such as General Physics. Each of the subelement panels was composed of from four to 11 persons designated from Office of Aerospace Research headquarters and field organizations, as well as from Headquarters, U.S. Air Force, and from Air Force Systems Command. The panel members were to separately review the relevance statements in their subelement and to classify each project into one of the following categories.

1. Work units considered relevant.

2. Work units considered relevant but inadequately justified.

3. Work units considered irrelevant.

The instructions provided that, to arrive at the final decision, the subelement panel place a project in the irrelevant category if one or more of the panel members voted for that category. The subelement panels which provided the initial screening placed 82 projects in the irrelevant category.

The second review level consisted of senior officers from Headquarters, U.S. Air Force; Office of Aerospace Research; and Air Force Systems Command. The senior officers' review team reviewed all projects that the subelement panel considered irrelevant and a sample of 5 to 10 percent of those considered relevant or in need of additional justification. The senior officers increased the number of irrelevant projects from 82 to 95.

The third review level included Air Force general officers and the Deputy for Laboratories, Office of Assistant Secretary of the Air Force (Research and Development). The Deputy for Laboratories informed us that he and the general officers had sampled the decisions made by the subelement panels and the senior officers' review team and had found a need for special reviews of projects in the general physics, nuclear physics, terrestrial sciences, astronomy and astrophysics, and biological and medical sciences subelements. The special committee established to reexamine these projects increased the number of irrelevant projects from 95 to 202. These results were subsequently reviewed by the Deputy for Laboratories. As discussed in detail on page 23, he reversed about 42 percent of the prior decisions to disqualify projects under section 203.

In February and April 1970, the Office of Aerospace Research, to ensure future compliance with section 203 requirements, issued instructions containing criteria for selecting and evaluating all research efforts to subordinate activities. These instructions provide for selective reviews by the Office of Aerospace Research of research proposals accepted by subordinate activities, as well as for reviews of the statements of relevance by the responsible Office of Aerospace Research scientific monitor.

A total of 1,896 basic research projects were reviewed, and 151, or about 8 percent, were classified as not meeting the section 203 requirements. Of the 151 projects, 72 involved about $3.9 million of fiscal year 1970 funds; nearly $23 million had been applied from inception of these projects.

In March 1970, the Office of Aerospace Research was given guidance regarding disposition of those projects not complying with section 203. The instruction provided that purchase requests involving fiscal year 1970 unobligated funds be withdrawn and that all projects having fiscal year 1970 or prior year obligated funds be terminated immediately, phased out before the normal expiration dates, or allowed to expire under the terms of the contracts or grants. It also required full justification of those projects to be continued beyond July 1, 1970.

In April 1970, the Office of Aerospace Research reported to Headquarters, U.S. Air Force, that, of the 151 projects disqualified, 139 were to be closed out on or before June 30, 1970. The remaining 12 projects were to be placed in other disposition categories--two were justified for continuing beyond June 30, 1970, two were moved to the relevant category, four were still under consideration, and four others were withdrawn.

Reversal of lower level decisions

Air Force records of the reviews made by the various review levels showed that generally there was agreement on what projects had or had not direct and apparent relationships to military functions or operations. However, we noted two significant exceptions.

The first exception involved the Air Force's nuclear physics program where the initial decisions by the subelement panel that most projects met the provisions of section 203 had been reversed by the next review levels. Ultimately, of the 27 projects in this program, 26 were disqualified under Section 203. The Deputy for Laboratories informed us that he and the Commander, Office of Aerospace Research, had reviewed the general direction of the Air Force nuclear physics program and had reached a decision that, because the program emphasized research in nuclear propulsion and new energy sources, it was not oriented toward specific Air Force functions or operations and should be phased out. The remaining project, which was determined to be in compliance with section 203, was transferred to the general physics program. About $12 million had been applied to the 26 disqualified projects.

The second exception was in the astronomy and astrophysics program where 88 projects had been reported to the Headquarters, U.S. Air Force, as not complying with section 203. This decision was reversed by the Deputy for Laboratories who reinstated 73 of the 88 projects, leaving only 15 in the disqualified category. He told us that his decision had been based upon careful consideration of the potential applications of this research to Air Force communications and surveillance systems. He stated that, since the members of the special review team were from scientific

areas other than astronomy and astrophysics, they appeared to have lacked detailed knowledge regarding potential applications in this area. He added that this review team had taken an ultraconservative approach inasmuch as if one or more members placed a project in the irrelevant category the team disqualified the project.

ARPA PROCEDURES AND RESULTS

Statements of relevance were required by ARPA for all active projects, even those for which no fiscal year 1970 funds were required. The ARPA Director initially requested that his eight program directors furnish him with lists showing the short titles of projects for which relevance statements would be submitted. These lists were reviewed by the Director and Deputy Director of ARPA for general consistency among the program directors as to approach in preparation of relevance statements.

We were advised that the wording of the final relevance statements reflected the joint effort of the project managers and program directors and, in some cases, contractor personnel. Supervisory review, we were told, was assigned to the special assistant to the Deputy Director of ARPA. In addition, ARPA's Director and Deputy Director reviewed a sampling of the projects. ARPA considered all of its 403 research projects relevant under section 203 criteria.

The Director of ARPA, in testifying before the House Committee on Armed Services on the fiscal year 1971 defense procurement authorization, made the following statement regarding the impact of section 203.

> "There was a rather perhaps unique situation in ARPA, such that the impact of section 203 was perhaps somewhat different for ARPA than elsewhere. When the Deputy Director and I came onboard ARPA as top management we felt that we wanted to direct ARPA toward highly significant military R&D [research and development] to a greater extent than had been the case before. So in late 1967 and early 1968, we went through a detailed review of all projects and directed our office directors to see whether or not the research we were doing would really, as we say, 'change the name of the game' in a military framework.
>
> "And if it did not, we wanted them reviewed and if possible strongly oriented toward defense. So that happened and that action happened to precede

section 203. So section 203 to us, reiterated, if you will, our selection criteria for all the projects that come in that we have to reject unless we could see where they would go in terms of the military capability transferable to the services. The effect of that was emphasized by section 203 in the following sense; we had to make it a matter of written record by project, down to the work level, of what the specific relevancy was of each project."

To ensure future compliance with section 203 provisions, the Director of ARPA issued a memorandum in January 1970 requiring a section entitled "Relevance to the DOD/ARPA function and mission" on all requests for new or extended projects. This section is to contain a clear description of the proposed project and its relationship to a specific military function.

GAO comments on adequacy of ARPA procedure

ARPA's screening procedure included fewer levels of examination and a broader interpretation of section 203 than the military services' reviews.

We reviewed ARPA's relevance statements of their current behavioral sciences research projects listed below.

Title	FY 1970 program (000 omitted)
Computer Analysis and Modeling of Human Behavior	$2,031
Center for Computer-Based Behavioral Studies	1,036
Action and Reaction in International Conflict Systems	69
International Security Data Archive Analysis Center	543
Conflict Dimension of International Affairs	163
World Conflict Event-Interaction Survey	90
International Alliances and Alignments	89
Advisor Selection and Training Research	590
Research in the Psychology of Languages	55
More Effective Individualized Instruction	109
Human Performance as Related to Basic Information Processing Functions	123
Perception, Cognition and Information Processing	300
Voluntary Enhancement of Physiological Functions	185
Conference on Voluntary Improvement of Individual Performance	10
User-Network Interaction ARPA Computer Network	25
Total	$5,400

For some of these projects, as the titles indicate, the direct and apparent relationships to specific military functions or operations may be questionable.

All these projects were considered by ARPA to comply with section 203. The purposes of the research as explained in the ARPA relevance statements, however, do not appear directly applicable to the solution of military problems or seem more appropriate for civil agencies. In contrast, as stated previously, the military services in their reviews disqualified certain projects because they were not directly related to military operations or because civil agencies had primary responsibility for the areas. Three of the ARPA projects are discussed below.

The purpose and goal of one project--a cooperative undertaking among behavioral scientists and computer experts at two universities for which ARPA has already provided approximately $4.1 million and plans to provide an additional $5.5 million--have been described by the performing university and confirmed by ARPA as follows:

> "Its purpose is to provide advanced computer tools and methods especially adapted and useful in the behavioral sciences.
>
> "The goal is to develop a consistent collection of methods by which a behavioral scientist may call up data from a variety of sources, organize, store, index, and label them, perfect and transform them, perform statistical analyses on them, build and test theoretical models, and predict outcomes that can be tested."

Thus the purpose of this project is not primarily to perform research related to military behavioral problems but to develop methods which may subsequently be used in performing research related to military or nonmilitary problems. ARPA's relevance statement for this project is shown as appendix II.

This project is subject to question on the basis that it is not the responsibility of the military to develop

techniques, methods, and tools which can be used in improving behavioral science research. This activity has broad national significance and may be more appropriate for the National Science Foundation. We note that Public Law 90-407, enacted July 18, 1968, which amended the National Science Foundation Act of 1950, provides authorization and direction for the Foundation to foster and support the development and use of computer and other scientific methods and technologies, primarily for research and education in the sciences.

Some of the behavioral sciences projects concerning international affairs may be more relevant to the Department of State than to DOD.

An example of this type of project is a study in "Conflict Dimensions of International Affairs," which has received support in the amount of $653,000. The purpose of this project is to develop a theory to link national attributes--such as wealth, size, and power--to long-run (5 to 10 years) forecasts of international military behavior, such as participation in military alliances and waging war. ARPA believes that the relevance of this project to DOD is the more adequate forecasting of important events and trends in international security affairs for long-range planning purposes. ARPA's statement for this project is included as appendix III.

Another project which has received support in the amount of $865,000 and which appears to be more appropriate for the Department of State has the following objectives.

1. To establish an International Security Data Archive and Analyses Center to manage and disseminate international and foreign area data developed by DOD and other agencies for purposes of building predictive models to anticipate international conflict events.

2. To coordinate independent scientific studies of international conflict into a unified and utilizable product.

3. To develop seminar and other procedures for rapid model building with provision for immediate validation, for prediction of the effectiveness of strategies to avoid or control international conflict.

ARPA believes this project can be applied to DOD's strategic planning and threat assessment. The relevance statement written by ARPA is included as appendix IV.

CHAPTER 4

EXAMPLES OF DISQUALIFIED PROJECTS

We were informed by the Deputy Director of Defense Research and Engineering that the reviews of all research efforts by upper echelons in implementing section 203 were useful and beneficial because that was the first time top management had taken a detailed look at the research which was being conducted. As previously mentioned, the section 203 reviews prompted the Air Force to phase out its nuclear physics research program and the Navy to sharply curtail its activities in this area. Further, some projects had been supported for 10 to 15 years, yet the military was still unable to meet the requirement of section 203 that each research project have a direct and apparent relationship to a specific military function or operation.

We examined the files of the Air Force's nuclear physics research program and the files of 19 projects from other programs which had been determined by the three military services to be in noncompliance with the provisions of section 203. Highlights of the nuclear physics program and 10 of the disqualified projects are presented below. In most cases the disqualifications of the projects by the military services involved one or both of the following reasons.

1. The research need was not a uniquely military problem, and a civil agency had research responsibility for the area.

2. The research was too far removed from actual application to have a direct relationship.

AIR FORCE NUCLEAR PHYSICS RESEARCH PROGRAM

The Air Force, under section 203, disqualified 26 of the 27 projects in the nuclear physics program. About $12 million had been expended on these 26 projects. Of this amount, about $2.3 million had been expended from 1953

on one project--Solar Flare Phenomena and Electromagnetic and Particle Environment of Space Radiation Hazards.

Historically, the Air Force has been involved in research that would develop new nuclear energy and propulsion sources. As stated in the Air Force publication entitled "Air Force Research Objectives 1969," the nuclear physics program was to focus on three areas of importance: cosmic rays, nuclear structures, and high-energy physics. The publication further stated that the goals of studying cosmic rays and nuclear structures were to (1) investigate new energetic processes that may lead to new schemes of power generation, (2) continue the determination of nuclear properties, such as energy levels, and (3) provide information on the origin, energy distribution, composition, and atmospheric attenuation of cosmic rays. The publication pointed out that the study of cosmic rays was important to the prediction of the severity and duration of radio communications blackouts.

The Deputy for Laboratories advised us that, after reviewing the Air Force's nuclear physics program under section 203, he believed that the type of research the Air Force had been pursuing was not directly related to Air Force functions. For example, although limited areas of nuclear physics research, such as the effect of cosmic rays on communications, were related to Air Force functions, other areas of cosmic ray study for schemes of power generation were not directly related and were properly the function of the Atomic Energy Commission and the National Aeronautics and Space Administration.

AIR FORCE RABIES PROBLEMS--RESEARCH ON BETTER PREVENTION IN SOUTHEAST ASIA AND OTHER EPIDEMIC AREAS

The research project was related to the development of a better rabies vaccine. The Air Force Office of Aerospace Research had sponsored this research from March 1969 in the amount of $56,801.

The project was disqualified during the section 203 review, because the review panel felt that rabies was not a unique military problem and that research in this area

should be conducted by the Communicable Disease Center of the National Institutes of Health.

We obtained information that the National Institutes of Health had been engaged in rabies research for over 30 years and had awarded 29 rabies research grants totaling $2.3 million over the past 12 years. One of the investigators currently supported for rabies research is the investigator conducting the Air Force's rabies projects.

AEROSPACE MEDICAL ASPECTS OF RAPID DIAGNOSIS OF DISEASE AND DETECTION OF PATHOGENS

The purpose of this research project was to develop techniques for the early detection and identification of viruses and other microorganisms.

It had been sponsored by the Office of Aerospace Research for 5 years in the amount of $372,201.

According to information provided by the Office of Aerospace Research, the review panel decided that the need for these clinical techniques was not unique to the Air Force, since it would use the techniques in the same way as would a civilian hospital. It was felt that research in clinical techniques was the responsibility of the National Institutes of Health.

AIR FORCE FLIGHT SAFETY RESEARCH--STUDIES OF THE BIRD-AIRCRAFT COLLISION PROBLEM

This project involved an examination into the environment of the whistling swan in the Chesapeake Bay and the factors that affect the swans' migrating behavior. The results were to be the basis for developing military and civilian procedures designed to reduce the chances of aircraft collision with swans. In 1962 one collision of a civilian aircraft with a whistling swan had been reported.

The Air Force Office of Aerospace Research had sponsored this research from February 1968 in the amount of $102,482.

The Air Force review panel found that this project did not meet the requirements of section 203, because it was oriented toward basic environmental studies of the whistling swan. The panel felt that, although this project might be of some value to the naturalist, the Air Force would not benefit from it.

METHODOLOGY FOR ANALYSIS OF INTERNAL SOCIAL MOVEMENT

This project was to develop methods and theory for the study of incidents of violent social protest and broad social movements in the context of social system change. The project was based on public records and historical documents of the 19th century from societies in two different cultures, western and oriental. It was felt that prediction of future social change would be of use to Air Force systems planners for environmental and political analyses. The Air Force had supported this project from 1966 in the amount of $229,585.

The Air Force determined that this project did not comply with section 203, because the Air Force felt that the project was more relevant to the mission of the Department of State than the Air Force. The Air Force review panel felt that section 203 was directed at research that could, or perhaps should, be supported by other agencies and therefore disqualified the project on that basis. The panel expressed the belief that the project should be continued under the support of the Department of State.

CONTROL OF DENTAL CAVITIES BY DIETARY MEANS

This research project comprised experiments on laboratory animals whereby changes in diet by specific additions of certain minerals might be measured for their effect in decreasing dental cavities, since the absence of these minerals was known to strongly influence animal and human health.

This project had been sponsored by the Office of Naval Research for 14 years in the amount of $256,033.

The project was disqualified because Navy officials believed that the project did not meet the direct and apparent relationship requirement of section 203. These officials were of the opinion that the method of dental care promised by this research did not meet the requirements of section 203 in the light of the short tenure of most naval personnel.

We believe that this project is more appropriate for conduct by the National Institutes of Health or possibly the National Science Foundation.

INVESTIGATIONS OF SKILLED
MUSCULAR RESPONSE LEARNING OF NAVAL TASKS

This research project comprised experiments with primates, to evaluate behavioral theory about responses to stimuli which, in turn, result in changes in subsequent stimuli. The purpose of the project was to gather background for behavioral concepts such as learning, motivation, and problem solving.

The Office of Naval Research had sponsored this research for 14 years in the amount of $279,866.

The Navy found that this project did not comply with section 203, because the study used rats and primates, rather than human beings, as its subjects for research. The research was considered too far removed from actual naval applications to have a direct relationship.

RADIO STAR
INTERFEROMETRY

This research project used antennas and receivers to observe radiations from celestial objects to determine their locations and identification. The research yielded information on properties of radio stars which had importance in the evolution of new types of navigation and electronic systems.

This project had been supported by the Office of Naval Research for 15 years. About $4,600,000 of Navy funds had been applied to the project.

This project was disqualified in the Navy review, because the research required a long-time effort which would involve many investigators throughout the world and because, in the reviewer's judgment, the research did not have a direct relationship to the Navy's needs. We were advised that a number of similar efforts were supported by the National Science Foundation.

RESEARCH IN THE THEORY OF RIEMANN SURFACES

This project comprised research to extend prior studies at a university concerning a theoretical concept, developed and defined by Georg Friedrich Riemann, a 19th century mathematician, to present a multivalued mathematical expression as a single-valued one. The Army Research Office-Durham and its predecessor organization had supported this research for 16 years in the amount of about $289,000.

The project was originally justified on the basis of the competence of the chief investigator, the National Academy of Science's high rating for originality and scientific merit, and acceptance of the project by five Army laboratories. These laboratories, however, commented that the project had no direct application to their military needs. The Army's justifications for renewing support for this research project were basically similar to its initial justification.

RESEARCH IN THE THEORY OF RIEMANN SPACES

The project comprised research in mathematical theory at another university by further developing existing theories about numbers in certain series arrangements and the variances in their values, specifically adapted to a series of numbers.

The work had been supported for 15 years by the Army Research Office-Durham and its predecessor organization to the extent of about $343,000.

The reputation of the principal investigator appears to have been the overriding consideration for accepting sponsorship of this project. His reputation, substantiated by technical publications and doctorate degrees, also influenced decisions to continue financial support. Relevance of the project to Army needs was not shown.

The project originally had been accepted largely because the National Academy of Sciences had attested to the reputation and competence of the principal investigator, as well as to the significance of his investigation program. Army laboratories indicated that the original proposal was good, overall, but one laboratory stated that the nature of the research was not such as would permit its early use in ordnance research and development work.

There was no indication that relevance to Army needs had been considered at all when the work was renewed for support eight times after the first year.

RESEARCH IN ALGEBRAIC TOPOLOGY

The project consisted of research to extend fundamental knowledge about a body of mathematical theory which was useful in relating difficult problems to simple ones--for example, a step-by-step mathematical process, such as a series of computations, would solve certain classes of computation problems under specified conditions.

Support for this research had been provided for 10 years by the Army Research Office-Durham and its predecessor organization in a total amount approximating $214,000.

In our opinion justifications for starting and renewing support for the project showed that the work had never been directly related to Army needs.

The original justification for support was a sufficiently favorable rating by the National Academy of Sciences; good, overall ratings by two Army laboratories; a reasonable budget; and the comment that there were only three other projects in the same field. There was no indication that military relevance had been considered. The Army laboratories which evaluated the original proposal indicated that it was weak in military relevance and weak overall, direct or indirect applications to any engineering problems in the present trend of applied mathematics were not likely, and application to ordnance research could not be predicted.

Evaluations by the National Academy of Sciences and Army laboratories were used as the basis for renewing support. It was noted that, of the Army laboratories that had been consulted to evaluate proposals in eight instances, none had indicated that the research work being performed was of significance to the Army.

APPENDIXES

SCHEDULE OF BASIC RESEARCH PROJECTS

DETERMINED BY THE MILITARY SERVICES TO BE DISQUALIFIED

UNDER SECTION 203 BY FIELD OF SCIENCE

Scientific area	Army		Navy		Air Force (note a)	
	Reviewed (note b)	Disqualified	Reviewed	Disqualified	Reviewed	Disqualified
Physics	162	21	340	79	274	39
Chemistry	168	21	73	2	94	21
Mathematics	120	17	286	6	207	10
Missiles	12	-	N/A	N/A	N/A	N/A
Electronics	195	-	110	12	156	-
Materials Sciences	134	-	203	2	98	3
Mechanics	131	3	247	6	157	2
Energy Conversion	37	1	86	1	111	1
Oceanography	N/A	N/A	302	30	N/A	N/A
Terrestrial Science	65	1	74	2	100	2
Atmospheric Science	88	-	38	-	222	-
Astronomy and Astrophysics	N/A	N/A	47	15	273	15
Biological and Medical Sciences	367	-	516	50	57	17
Behavioral and Social Science	22	-	171	14	29	3
Other	N/A	N/A	N/A	N/A	2	1
Total	1,501	64[c]	2,493	219[d]	1,780	114[e]

[a]The schedule does not show the 116 projects reviewed and 37 disqualified in April by the Air Force subsequent to the initial review because this information was not available.

[b]Active basic research projects are shown for the Army as of May 5, 1970, because it did not retain a record of the number of projects reviewed by scientific area. The total reviewed by the Army in January and February 1970 was 1,579.

[c]The Army did not disqualify any in-house research; therefore none are included in the total research projects disqualified.

[d]There are 48 in-house projects included in the 219 projects disqualified by the Navy.

[e]There are nine in-house projects included in the 114 initially disqualified by the Air Force.

Relevance Statements - Behavioral Sciences

Computer Analysis and Modeling

The Department of Defense is responsible for developing and operating as economically and reliably as possible a large number of complex man-machine systems. These include: hardware for effective individual and group use; training and educating thousands of men and assigning them to over 2000 different military specialties. Accordingly, DoD personnel need to be able to determine the effects of large numbers of possible changes in engineering and personnel policy without actually implementing these changes in the operating system. This project will develop underlying methods and techniques for analysis and testing which can aid Defense officials to make such determinations.

This effort will develop more powerful and effective behavioral science tools for the following research operations:

1. Flexible access and handling of large bodies of data including updating information and combining categories of information.

2. Analysis of time-series and trend data in which events are not statistically independent. Most indicator systems whether of counter-insurgency situations or the career progress of Project 100,000 men have this attribute of statistical dependence.

3. Mapping and analysis of linkages in networks, i.e., of the ways in which elements of a complex system (e.g., a division, a warning system, an alliance) interact with each other.

4. Formalization of alternative procedures for data transformation, scaling and data reduction with resulting clarification of the distortions unique to each procedure

5. Determination of cause and effect relationships between personnel, group societal, and international phenomena

6. Formal analysis of the content and flow of language

7. Simulation and modeling, in particular, estimating parameters, validating models, and specifying their implications.

Examples of the relevant applications from work units within these research areas are as follows:

1. Data Management -- Convenience to work with large sets of data quickly without going through a long period of preparing the data specifically for each analysis.

Examples of utility to DoD:

a. Data exists on the depth of harbors and harbor enterances in various locations which may be appropriate for development for military purposes. One could, with procedures under development by this project, rapidly retrieve a map marked with the harbors for which there is data, and by indicating a specific harbor, a blow up with the isometric depth range at two meter intervals and other similarly specific information. In other words, the information itself will be dealt with directly and efficiently, not the files that contain the information.

b. A sizeable project which is unique to the Department is the maintenance of inventory of spare parts. A data base of the type studied under this contract is essential for such a huge information system. The control of millions of spare parts, engineering changes, obsolescence and other factors involved in a data base related to a large capital equipment system which is evolving over time will be come feasible.

2. Time Series -- Analysis of data extended through time

Examples:

a. Using such data as a number of serial reports based on aerial and on ground observation, and reports of possible missile site construction for 25 geographical areas located over the last ten years, patterns could be searched that could have predicted other major crises or overt moves as well as the Cuban missile crisis.

b. Experiment on watch keeping in space stations. Responsiveness to stimuli vs. time of day, body temperature, length of watch, over watch and other duty periods could be analyzed as time series for improvement in performance on space stations.

c. The analysis of equipment effectiveness over time to identify obsolescence, unusual wear or breakdown occurrences. Generation of a system of control tailored to the anticipated wear characteristics of the equipment.

3. Multivarate Analysis/Multi-dimensional scaling -- Analysis of data that involves the interrelationship of many variables in order to clarify and quantify the nature of their combined effects.

Example: We have data on age, school background, family socio-economic status, aptitude (test scores), athletic ability, language ability, etc., on a large set of volunteers. How can we predict success in the many possible alternative military careers?

4. Causal Analysis -- Imputation of causation in complex processes

Example: Records exist of all fighter pilots in Korean War. We know the types of planes, weather conditions, age, training, etc., of pilots, as well as many characteristics of enemy air activities. What leads to the "Ace" phenomena? What caused a few pilots to shoot down many enemy aircraft while others shot down none? We have to know actual causes because it would do no good to locate variables that only correlate with but are not causes of the success of the pilot.

5. Analysis of Text -- Analysis of information represented in the form of natural language text.

Example: From the text of debriefings of pilots in computer processable form, we could attempt to determine the cause of aircraft loss under certain unusual conditions. If an aircraft was passing through the sonic barrier and the outside temperature was just below freezing, text analysis programs could be used to search automatically through all the briefing text for crossing sonic barrier just below freezing (and many other phrases with similar meaning) to isolate all text relating to the conditions that we suspect to be related to the loss.

6. Modeling -- Construct specific theory of what takes place in given situations or processes, stating the relationships toward the whole among all the significant variables. A computer program model is a definite theory expressed in the form of computer programs that operate upon or are related to data stored in the computer. Computer based models employ data management and data analysis and provide a superior way of connecting theory with data in planning, problem solutions, decision-making, etc.

Examples of utility for DoD problems:

a. Plan for an airdrop of safe conduct passes within several hours. Given: Some knowledge of enemy language diversity; enemy geographic distribution; wind force direction

b. Determination of an optimum maintenance schedule for aircraft, given records of components and system failures and of mission aborts.

c. Design of a detection system (sonar, radar, sentry, etc.) to prevent infiltration (submarines, aircraft, troops), given knowledge of the detection performance of individual detectors. We want to determine the space layout and other characteristics of the system, and then go on to relate its performance to design factors in such a way as to continually improve the performance.

d. Design a command and control system. Enough is known about the performance and cost characteristics and inter-relationships of computers, communication equipment, software and human factors so that the immediate problem is to find an optimal design to make a complex model corresponding to various concepts and the overall system design.

e. Design of training courses. Given various data about individuals available for training, about the various tasks for which they are to be trained, and about the relations of aptitudes to success in the past, we want to make the best allocation of available teachers, classrooms, instructional material, and other resources.

f. Retargeting. New target plans must sometimes be created because situations arise which are not covered by any available contingency plan. We have to take into account many factors relating to availability and capability of our weapons and those of the enemy, the characteristics of possible targets, and their significance to the enemy and to us.

APPENDIX III

Relevance Statements - Behavioral Sciences

Conflict Dimensions of International Affairs

This contract will develop a theory to link national attributes such as wealth, size and power to long-run (5 to 10 years) forecasts of international military behaviors such as participation in military alliances and waging war, with special emphasis on Asian military affairs. DoD utilization can be expected from use by various military planning and policy groups for strategic decision making.

The relevance to DoD is for more adequate forecasting of important events and trends in international security affairs. This is of particular interest to Joint Staff and the services' long range planners.

In preparing the Joint Strategic Long Range Study; Air Force Policy Objectives Series Papers; Army Basic Strategic Estimate; Navy Long Range Strategic Study and Mid-range Study, some of the planners have been briefed as regards these forecasts derived from quantitatively based theory. Discussions are underway to provide a continuous mechanism for getting the forecasts to the planners in a regular fashion.

Method and data development here has been applied to policy study contracted by Air Force of Doctrine, Concepts and Objectives.

Relevance Statements - Behavioral Sciences

International Security Data Archive and Analysis Center

1. Development of International Relations Archive

This project will manage and disseminate international and foreign area data developed by DoD and other government agencies for purposes of building predictive models to anticipate international conflict events. Application is to planning functions of JLRSS and JCS.

2. Coordination of Independent Scientific Studies of International Conflict

This effort will promote and facilitate voluntary coordination of ARPA-sponsored Quantitative Political Science research efforts. Application to operations of strategic planning and policy assessment groups will come from organization and integration of independent research efforts into a unified and utilizable product.

3. Development of Models for Prevention and De-escalation of Conflict

This project will develop innovative seminar and other procedures for rapid model building with provision for immediate validation, for prediction of effectiveness of strategies to avoid or control international conflict. Application will come through use by strategic planning and threat assessment groups such as JLRSS, JCS, and JWGA.