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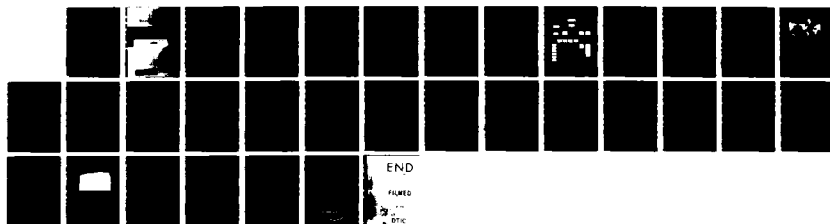
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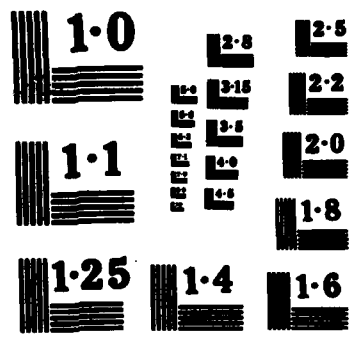
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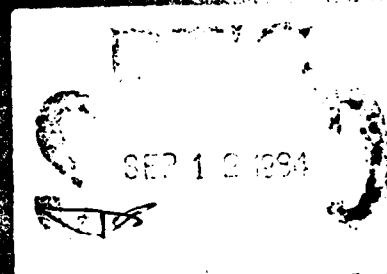


Annual Report

AD-A145 590

Center for Naval Analyses

1983



A Division of the



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The CENTER FOR NAVAL ANALYSES is a non-profit Federal Contract Research Center (FCRC) that traces its origins to 1942, when the Anti-Submarine Warfare Operations Research Group was created to help defeat the U-boats. CNA's current efforts for the Navy and Marine Corps range widely, from support of training and testing activities in the fleet to the evaluation of future technologies, forces, and strategies for top-level decision makers in Washington. Research is conducted mainly in CNA's four line-divisions: Naval Warfare Operations, Naval Planning and Management, Marine Corps Programs, and Field Operations. CNA's research program is conducted in consultation with the Department of the Navy's Policy Council for CNA, which is chaired by the Assistant Secretary of the Navy for Research, Engineering and Studies.

CNA also conducts research for such other national security clients as the Office of the Secretary of Defense and the intelligence community. CNA's non-defense division, the Public Policy Institute, applies the Center's analytical skills to a broad range of public policy issues.

Under CNA's matrix organization, the expertise that enables the divisions to develop relevant and timely analyses of high quality is developed through six research departments: Air Warfare, Submarine and Antisubmarine Warfare, Surface Warfare, Amphibious and Land Warfare, Policy and Resources, and Information Sciences. The departments support methodological research, provide training and career development opportunities in the various specialties, and perform quality control functions.

CNA's research staff - research managers, professional staff members, and technical aides numbers 200. Of the professional staff, 90 percent hold advanced degrees and about half have served as CNA field representatives. On average, members of the professional staff have 10 years' experience in defense analysis. The experience of the civilian staff is augmented by that of the 19 Naval officers who are assigned to work in CNA's research program.

In 1983, following a competition among several institutions, the Department of the Navy selected the Hudson Institute to manage CNA.

The Hudson Institute, founded in 1961 by the late Herman Kahn, is a non-profit organization dedicated to the examination of critical issues of policy in the public interest. The Institute serves as a research bridge between organizations that may be too close to problems to analyze them (e.g., government agencies) and those that may be too far removed to evaluate them effectively (e.g., academic institutions).

Hudson studies cover a wide variety of global, national, regional, and local issues, from narrowly professional concerns to problems common to an entire industry, country, or group of nations. There are five basic areas of study at the Hudson Institute: national security and international order, energy and natural resources, American domestic issues, economic issues, and studies of the future. Hudson's most enduring concentration has been in the areas of national security policy and arms control. The Institute's more recent studies have focused on military technology, mobilization, protracted war, Soviet and European trends in national security policy, and the changing role of the U.S. Navy.

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Annual Report

1983

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Center for Naval Analyses
a division of the Hudson Institute
2000 North Beauregard Street
Alexandria, Virginia 22311

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Foreword

The Report

In August 1983, the Department of the Navy selected the Hudson Institute to manage CNA, following a competition among several distinguished institutions. Hudson accepted the responsibility with the understanding that CNA's basic charter would remain unchanged. That charter is to give Navy and Marine Corps decision makers an objective, analytical basis for selecting, operating, and supporting the nation's naval and amphibious forces.

The Center for Naval Analyses became a division of the Hudson Institute on 1 October 1983. This annual report therefore looks ahead as well as back. In addition to describing CNA's accomplishments in 1983, we feature Hudson's plans for making the Center even more effective than before.

Those plans are based on the detailed review of CNA's management and operations that Hudson undertook from October to December 1983. Joining me and other Hudson officials on the review team were several distinguished experts in naval matters: Admiral Robert L. J. Long, U.S. Navy (Retired), former Commander-in-Chief, United States Forces, Pacific, and former Vice Chief of Naval Operations; Robert Murray, former Under Secretary of the Navy; Philip A. Odeen, former Director of Program Analysis, National Security Council; and R. James Woolsey, also a former Under Secretary of the Navy.

In December, Hudson's Board of Overseers for CNA approved the team's report and

recommendations, as did the Department of the Navy's Policy Council for CNA. Many of the team's findings and recommendations are reflected in the new organization of CNA, which took effect in February 1984 and is described in part I of this annual report. Briefly, the organization is designed to further these ends:

- ✱ Support for CNA's field program, which provides analytical services to some 40 Navy and Marine Corps commands, worldwide;
- ✱ Assurance that CNA-Washington studies will reflect the "real-world" experience gained in the field;
- ✱ Coherent planning of the CNA research program, with attention to the most pressing issues faced by top-level decision makers;
- ✱ Development and maintenance of the expertise needed to address those issues.

We see the new organization as a way of meeting these aims by building on CNA's strengths, which are illustrated in the sample of results for 1983 given in part II. We have organized the examples along the lines of the new organization, to emphasize the underlying continuity.

The key to any organization's strength is its people. CNA has — and has long had — an excellent research staff, which is backed up by outstanding technical aides and

administrative and support personnel. Part III profiles the research staff.

Part IV summarizes CNA's finances for fiscal year 1983. Although most of CNA's funding derives from its analytical efforts for the Navy and Marine Corps, CNA's funding depends, in the long run, on more than the Services' support. Defense officials and members of Congress must be satisfied that CNA uses its expertise to give the Navy and Marine Corps a candid and objective view of their plans, programs, and operations. In addition to guiding CNA's research program toward the more important issues facing the

Services, the Board of Overseers must help to preserve the balance between closeness and detachment that CNA must bring to its work. There can be no doubt that CNA's new Board, whose members are listed below, has the strength of character needed to maintain that balance.



THOMAS D. BELL, JR.
President of the Hudson Institute and
Chairman of the CNA Board of Overseers

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Vice President, Center for Naval Analyses

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I. The "new" CNA

The Center for Naval Analyses operates as a not-for-profit Federal Contract Research Center, under a Basic Agreement between the Department of the Navy and the Hudson Institute. The terms of that agreement afford CNA the access and continuity needed to understand thoroughly the Navy and Marine Corps and their problems, and to accumulate the analytical tools and data needed to attack those problems effectively.

CNA is thus uniquely positioned to give Navy and Marine Corps decision makers objective, relevant, and timely analyses of high quality. CNA has a particularly valuable asset in its field program, which should allow studies and analyses for decision makers in Washington to reflect operational realities. The new organization of CNA was designed to realize that goal, to foster analyses that are more timely and relevant, and to ensure the quality and objectivity of CNA's work.

As shown in the chart on the next page, the main feature of the new organization is a matrix of "divisions" and "research departments." Through the divisions, CNA can be responsive to the pressing analytical needs of the Navy and Marine Corps — in the field and in Washington. These divisions also perform a limited number of defense studies for such clients as the Office of the Secretary of Defense.

The Public Research Institute conducts non-defense research into issues with significant public-policy implications.

The research departments foster the development and maintenance of expertise

and its proper application to the needs of CNA's clients, defense and non-defense. Each member of the research staff belongs to one of the research departments; assignments to projects depend on clients' needs and staff members' qualifications.

The following sections describe the specialties of these research units.

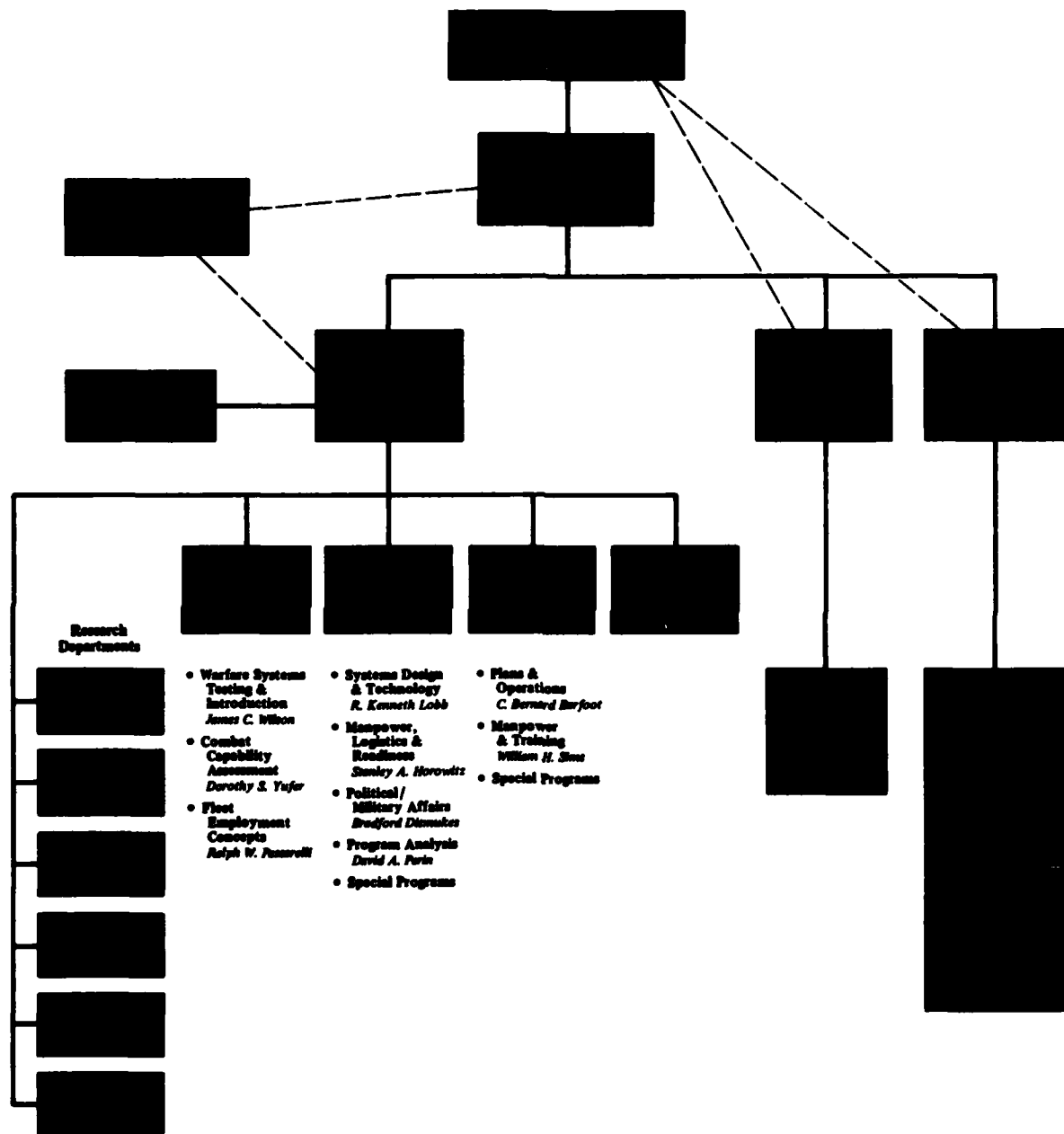
DEFENSE-RESEARCH DIVISIONS

With the exception of the Field Operations Division, through which analysts are assigned to Navy and Marine Corps commands worldwide, the divisions are organized into programs.

Naval Warfare Operations

Working with the Commander, Operational Test and Evaluation Force, the numbered fleets, and the Office of the Chief of Naval Operations, analysts in *Warfare Systems Testing and Introduction* aid in the operational testing and evaluation of weapon systems, sensors, ships, and aircraft and their introduction into the fleet. Their involvement may take the form illustrated in section II under "Night Raider" or it may take the form of assistance in the planning and reconstruction of tests and exercises.

Combat Capability Assessment analyzes fleet exercises and operations to assess the capabilities and estimate the future performance of battle forces and weapon systems. The program's primary clients are the fleet commanders and the Director of Naval Warfare. Much of this work is used



by the Director of Naval Warfare in the preparation of his annual appraisals of naval warfighting capability for the Navy's Planning, Programming, and Budgeting System.

Also for these clients, ***Fleet Employment Concepts*** develops and helps to test concepts for integrated operations by forces in various naval missions and areas. This program serves as CNA's focal point for wargaming, a tool used increasingly by clients in the Navy to investigate the merits of different concepts of operation.

Naval Planning and Management

Analysts in ***Systems Design and Technology*** help to shape and evaluate new concepts for ships and aircraft, weapon systems, sensors, and communication-information systems. They also help to structure effective research, development, and evaluation programs for such clients as the Navy's Director of Research, Development, Test, and Evaluation.

Manpower, Logistics, and Readiness develops and assesses ways to enhance the personnel and material readiness of the fleet. The program's studies help the Navy to improve its readiness within resource constraints. Clients include the Chief of Naval Personnel, Deputy Chief of Naval Operations (Logistics), Director of Naval Reserve, and Director of Navy Program Planning.

Major developments in international politics, economics, and military affairs are analyzed in ***Political-Military Affairs***. The emphasis is on helping fleet commanders and Navy leaders in Washington anticipate new mission requirements. The primary client is the

Deputy Chief of Naval Operations (Plans, Policy and Operations).

Areas of emphasis in ***Program Analysis*** include resource analysis and program planning issues that cut across the responsibilities of many Navy officials. The program also conducts analyses to improve the methods and processes used in Navy resource planning and management. The primary client is the Director of Navy Program Planning.

Special Programs comprises efforts to help senior Navy officials design, manage, and conduct large-scale studies that involve not only CNA but other analytical organizations and Navy offices, as well. Typically, such studies address major issues raised by the Secretary of the Navy or Chief of Naval Operations.

Marine Corps Programs

Plans and Operations conducts planning studies for Headquarters, Marine Corps, and the Marine Corps Development Center, and carries out operations analyses for the Fleet Marine Forces. The planning studies deal mainly with the costs and effectiveness of alternative future systems for amphibious assault, ground combat, tactical aviation, antiair warfare, logistic support, intelligence, and command, control, and communications. The operations analyses focus on the performance of current and new systems in the Fleet Marine Forces.

Working mainly with the Manpower and Training Departments of Headquarters, Marine Corps, analysts in ***Manpower and Training*** address all aspects of manpower policy and personnel administration:

accession criteria, recruiting, testing, training standards and methods, personnel assignment, performance evaluation, compensation, and retention. In addition, this program provides technical advice and analytical support to the Marine Corps on joint-service issues.

Special Programs conducts studies analogous to those in the Special Programs area of the Naval Planning and Management Division.

Field Operations

CNA's field program is unique in the defense-analysis community, in which analysts are assigned to the 40 Navy and Marine Corps commands shown in the map and list on page 6. Field representatives spend long enough at their assignments — normally two years — to know the forces and systems they are analyzing, but not so long

MANAGEMENT RESPONSIBILITIES

Under the guidance of the *Board of Overseers*, the *President* is responsible for the successful execution of CNA's research mission and supporting functions. He works with the Navy's CNA Policy Council and other senior Department of the Navy officials to see that CNA's research program is aimed at significant issues. The President also attends to CNA's relations with the broader defense community in the Executive Branch and Congress.

The *Senior Vice President and Director of Research* is responsible for the execution of the research program, and for maintaining the overall quality of CNA's work. Policies with regard to client relations, types of research, and research priorities are developed by the President and Senior Vice President in consultation with the *CNA Research Policy Council*, which also includes the other Vice Presidents, the Research Department Directors, and the Director for Naval Matters.

Division Vice Presidents plan and oversee most of CNA's defense research. They maintain close contact with Navy and Marine Corps officials, help to determine what work CNA should undertake, set the parameters and goals for each study, and see that key decision makers are apprised of progress and results. Working

under them, *Program Directors* are responsible for the planning and execution of projects in their respective areas. They, too, maintain close contact with their clients to see that research is aimed at the right problems. Within the programs, *Project Directors* plan projects in detail, assign tasks, monitor progress closely, and see that research stays on target, through frequent consultation with their immediate clients. Project Directors also take the lead in preparing briefings and documenting results.

Research Department Directors have primary responsibility for the administration and development of CNA's research staff. They participate in the hiring and training of new staff members and in the assignment of personnel to research projects in the divisions. Research Department Directors are also responsible for ensuring the development and maintenance of CNA's analytical expertise. Specifically, Research Department Directors lead research aimed at building and improving models and data bases, and occasionally direct major CNA studies. They also organize courses and seminars, and sponsor such career-enhancing activities as the preparation of papers for professional meetings.

The *Director for Naval Matters*, a senior Navy captain, is assigned to the Center

with the concurrence of the President of CNA. The DNM has administrative responsibility for the Operations Study Group (see below), and maintains liaison with the Bureau of Naval Personnel to keep the Operations Study Group staffed with qualified personnel. He also conducts special analyses within CNA, as directed by the Senior Vice President.

The *Operations Study Group (OSG)* comprises the 19 Naval officers and 3 enlisted personnel assigned to CNA as working members of the analytical and support staffs. They are selected on the basis of military experience and performance, as well as academic background (15 of the officers hold advanced degrees). Aside from their valuable analytical contributions, the members of OSG provide the rest of CNA's research staff with practical experience, technical knowledge, and a user's point of view.

In addition to overseeing the Public Research Institute, the *Vice President and Secretary to the Board* sees that the regular meetings of the Board of Overseers provide adequate and accurate information about CNA's research and business activities. He also keeps the Board abreast of important developments throughout the year.

that they lose their detached point of view. Returning field representatives apply their invaluable experience to projects for Navy and Marine Corps offices in Washington. Analysts in the field regularly request and get support from Washington-based analysts. This assistance often takes the form of sending Washington-based analysts to help the field representatives plan, observe, and analyze large-scale exercises and tests.

The main emphasis in the division remains what it was when CNA's forerunner, the Anti-Submarine Warfare Operations Research Group, was formed in 1942 — getting the most out of the forces at hand by sending scientists to work with the forces. Their work supports and complements that of the Naval Warfare Operations Division and the Marine Corps Plans and Operations Program; it falls into three categories: evaluation of system performance, tactical development and evaluation, and assessment of fleet effectiveness.

System performance is evaluated both before and after systems reach the fleet, and the evaluations help the Services to decide whether to accept new systems and how to modify them to make them more effective. The combat effectiveness of forces also depends critically on sound tactical doctrine; about half the field representatives contribute directly to the Navy's Tactical Development and Evaluation Program. Field representatives also help fleet commanders to assess the effectiveness of forces through the planning, reconstruction, and analysis of major fleet exercises. Analyses of individual exercises point the way to specific improvements in training and operational procedures; summaries of many exercises help to form realistic estimates of force effectiveness.

PUBLIC RESEARCH INSTITUTE

CNA's Public Research Institute (PRI) was established in 1970 in response to a suggestion

RESEARCH-SUPPORT ACTIVITIES

The *Vice President for Finance and Administration* is responsible for all matters relating to financial and contractual management, for programs affecting physical security, for compliance with the Industrial Security Regulations of the Defense Investigative Service, for publication and distribution of research reports, and for CNA's computational facilities. These activities are organized into six departments:

Computing Services is responsible for operation of the computer center, for centralized programming, and for a proper match between the capabilities of computing resources and the needs of CNA users.

Finance and Accounting provides cost and management accounting reports, financial management services, contract administration, and procurement services.

Information Services acquires, disseminates, and controls research materials. This department is also responsible for managing CNA's classified and unclassified libraries, and for developing and maintaining on-line access to sources, through CNA's computer.

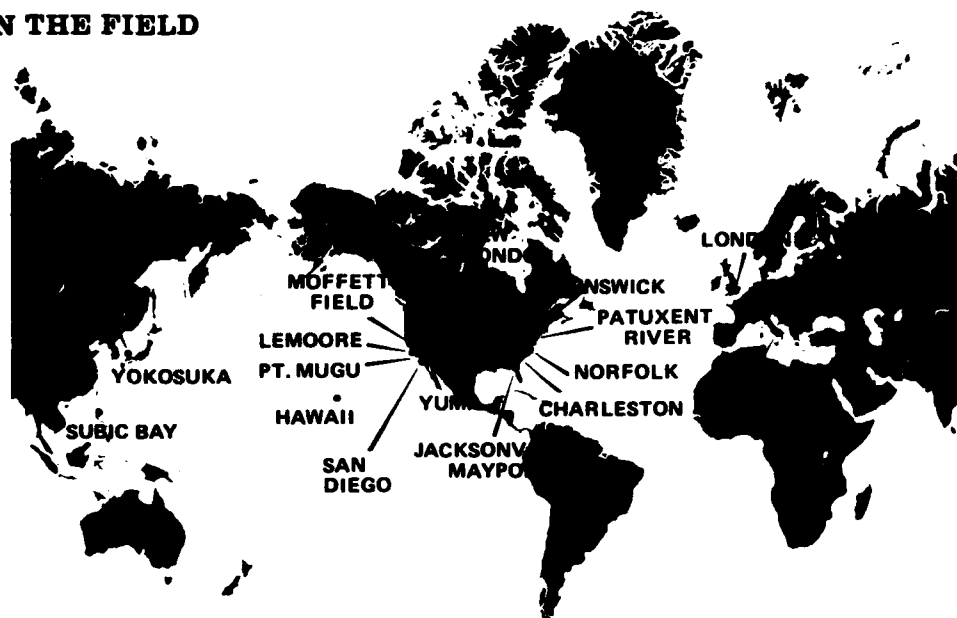
Personnel provides recruiting, interviewing, and testing services, maintains personnel records, administers

the salary and fringe benefits programs, and manages CNA's Equal Employment Opportunity and Affirmative Action programs.

Publications comprises the editorial staff and production center. It provides editorial, composition, graphic arts, and reproduction services to all components of CNA, and prepares special publications.

Security assures compliance with the Industrial Security Regulations of the Defense Investigative Service and is responsible for providing building maintenance and office service support.

CNA IN THE FIELD



BRUNSWICK

Commander, Patrol Wings, Atlantic

CHARLESTON

Commander, Cruiser-Destroyer Group Two

CHINA LAKE

Air Test and Evaluation Squadron Five

GAETA

Commander, Sixth Fleet

HAWAII

Commander in Chief, Pacific Fleet
Commanding General, Fleet Marine Force, Pacific
Commander, Third Fleet
Commander, Submarine Force, Pacific

KAMISEYA

Commander, Patrol and Reconnaissance Force,
Seventh Fleet

LEMOORE

Commander, Light Attack Wing, Pacific

LONDON

Commander in Chief, U.S. Naval Forces, Europe

MAYPORT

Commander, Cruiser Destroyer Group Twelve
Commander, Carrier Group Six

MOFFETT FIELD

Commander, Patrol Wings, Pacific

NAPLES

Commander, Battle Force, Sixth Fleet
Commander, Submarine Force, Sixth Fleet
Commander, Maritime Surveillance and
Reconnaissance Force, Sixth Fleet

NEW LONDON

Commander, Submarine Development Squadron Twelve

NORFOLK

Commanding General, Fleet Marine Force, Atlantic
Commander, Second Fleet
Commander, Carrier Group Eight
Commander, Tactical Wings, Atlantic
Commander, Surface Warfare Development Group
Tactical Training Group, Atlantic
Commander, Operational Test & Evaluation Force

PATUXENT RIVER

Air Test and Evaluation Squadron One

PT. MUGU

Air Test and Evaluation Squadron Four

SAN DIEGO

Commander, Naval Surface Force, Pacific
Commander, Naval Air Force, Pacific
Commander, Cruiser-Destroyer Group Five
Commander, Antisubmarine Warfare Wing, Pacific
Commander, Fighter Airborne Early Warning Wing, Pacific
Tactical Training Group, Pacific
Deputy Commander, Operational Test & Evaluation
Force, Pacific

SUBIC BAY

Commander, Carrier Striking Force, Seventh Fleet

WHIDBEY ISLAND

Commander, Medium Attack Tactical Electronic
Warfare Wing, Pacific

YOKOSUKA

Commander, Seventh Fleet

YUMA

Commander, Marine Aviation Weapons and Tactics Squadron

by the Secretary of Defense that the talents and techniques that had been applied successfully to defense analysis by such organizations as CNA be applied to non-defense problems, as well. PRI has worked on such subjects as the effects of imports on employment, the effects of technical progress on the labor market, and the adequacy and economic effects of unemployment insurance systems.

In the past, PRI's work has been mainly economic studies for federal agencies. Under the Hudson Institute, PRI will take on a broader range of studies for a greater variety of clients, while still restricting its work to important issues of public policy and always safeguarding the confidential relationship CNA has with its defense clients.

RESEARCH DEPARTMENTS

A matrix organization differs from the traditional line organization by assigning separate responsibility for the management of key resources — in CNA's case, the research staff.

As indicated earlier, the research departments enhance the quality of CNA's efforts for its clients by building and maintaining expertise. The departments do this in three main ways: by conducting research that is aimed at developing models and data bases, by organizing courses and seminars for analysts,

and by supporting analysts' participation in outside professional activities. Briefly, these are the departments' areas of concentration:

- *Air Warfare* provides expertise in all aspects of Navy and Marine Corps tactical aviation, other than air ASW.
- *Submarine and Antisubmarine Warfare* comprises specialists in surface, air, and submarine ASW, and in submarine and mine warfare.
- *Surface Warfare* specializes in Naval surface forces, systems, and operations other than those involved in tactical aviation and ASW.
- Analysts in *Amphibious and Land Warfare* specialize in the forces, operations, and systems of Marine Air-Ground Task Forces and Amphibious Task Forces except for tactical air.
- The *Policy and Resources* department fosters such non-warfare disciplines as political science, economics, cost analysis, logistics, and management science.
- *Information Sciences* builds and maintains expertise in the technologies, systems, processes, and analytical techniques that bear on the role of information in combat, combat-support, and management functions.

II. 1983 results

The examples given here represent only a portion of CNA's research during fiscal year 1983. Classified details have, of course, been excluded. Nevertheless, these brief descriptions give a flavor of the research CNA does for its defense and non-defense clients. The examples of defense research are arranged to correspond to CNA's current organization. They are followed by examples of non-defense work by the Public Research Institute.

NAVAL WARFARE OPERATIONS

Modeling Harpoon's Performance

Harpoon is the Navy's current long-range antiship missile. It can be launched from aircraft, surface ships, and submarines to ranges as great as 60 miles. Navy operators continuously seek to improve the weapon's tactical use, as weapon designers look for ways to improve the missile's performance. To accomplish these aims, tacticians and engineers must be able to predict how Harpoon will perform in combat.

Live firings against target hulks are one source of information about how well Harpoon works, but such tests are expensive and thus limited in number. Moreover, the data they provide reflect missile performance under test conditions, where considerations of safety and other constraints produce somewhat unrealistic results. Analysts and engineers have therefore tended to rely on theoretical models to augment test results. Aware that many different organizations had developed their own models, and thinking that there might be errors and inconsistencies in the models' designs, the Harpoon Project

Office asked CNA to undertake a detailed evaluation of six widely used models.

CNA set out to answer three specific questions. First, did the models yield similar results when applied to identical problems? Second, what were the causes of any significant differences in the models' predictions? And third, what types of data would be needed to validate the models? As a first step toward answering these questions, CNA analysts developed a set of ten hypothetical scenarios. These scenarios were designed to focus on significant characteristics of the Harpoon missile and over-the-horizon engagements. Some of the characteristics examined were seeker logic, effects of countermeasures and environment, errors associated with long-range targeting, and target signature. Each of the developing organizations used its models to calculate results for the ten scenarios. By an iterative process, CNA analyzed the results, pointed out errors, and analyzed the results obtained after errors had been corrected.

The CNA analysts found that five of the six models contained serious errors or omissions in the portions of the computer code representing the Harpoon seeker and its associated logic. These errors became striking when the models were applied to scenarios in which accurate modeling of seeker performance is particularly important — when the specified missile aimpoint would place the targeted ship near the edge of Harpoon's search pattern, for example. In such cases, the models' predictions of acquisition probability were distributed widely, in fact, almost uniformly between zero and one.

After the errors in seeker modeling were identified and corrected, the models were still found to disagree for some of the more complicated scenarios. These disagreements were traced to differences in the estimates used for various missile parameters. In some cases, as when estimating the detectability of various classes of surface ships in clear and rainy weather, a lack of suitable experimental data forced the developing agencies to rely on theoretical calculations, and different modelers chose different analytical approaches. In other cases, the modelers apparently consulted conflicting sources of data.

As a result of CNA's analysis, the models' accuracy and usefulness are improving. All of the errors that CNA identified have been corrected by the developers, and the six models now yield similar results for the more important scenarios. In addition, the Harpoon Survivability Assessment Program has set up a group to establish a consistent and correct set of parameter values for use by modelers. Finally, the Harpoon Project Office intends to require a similar analysis of consistency for future models of Harpoon variants. These steps will help analysts to provide the fleet with more accurate assessments of tactics, and they will help engineers to better evaluate proposed improvements in Harpoon's design.

Night Raider

CNA's research horizons expanded in 1983, with its involvement in Special Project Night Raider (SPNR). SPNR is one of a series of Special Projects being conducted by the Joint Chiefs of Staff to develop, test, and improve tactical commanders' use of intelligence information. As executive agent

for SPNR, the Director of Navy Command and Control turned to CNA for help.

CNA is coordinating SPNR and its six related tests, in addition to analyzing and reporting the results of the tests, which will take place in connection with two Naval exercises in 1984. In 1983, the CNA team of analysts assigned to SPNR identified the tasks to be performed in the tests and drew up detailed plans, specifying the objectives of each test, measures of effectiveness, analytical methods, and data requirements.

After training data collectors and monitoring the tests, the CNA team will analyze and report the results. These results are expected to shed light on the types of tactical information obtainable from space systems, procedures for obtaining the information, ways of tailoring information for amphibious forces, and methods of improving the fleet's command, control, and communications.

Improving Today's Air Defenses

The introduction of advanced sensors and weapon systems on U.S. and Soviet ships and aircraft has increased the complexity of anti-air warfare (AAW) to the point that it is difficult to develop AAW plans and manage their execution. CNA has assisted in this problem by providing the Navy with a desktop computerized AAW Tactical Decision Aid.

Naval AAW originated in efforts to defend ships against attacks by manned bombers. For most surface ships, this meant shooting down the attacking bombers with guns, which proved effective because the bombers had to penetrate well into the range of the ships' guns to deliver their bombs. From

the start, the aircraft carrier and its escort ships had additional defenses in the fighter aircraft aboard the carrier. Fighter aircraft could be deployed on combat air patrol (CAP) stations at some predetermined distance from the defended ships and along routes the bombers were expected to attack. Interposing themselves between the defended ships and raiding bombers, the fighters could intercept and engage the bombers with their guns. Today, the shipborne AAW guns have evolved into sophisticated point-defense systems, and the fighter is now armed with several types of guided air-to-air missiles to enhance its effectiveness against the many and fast targets it is likely to encounter.

The deployment of nearly autonomous guided antiship missiles (ASMs) aboard Soviet ships, submarines, and aircraft has necessitated major changes in AAW weapon systems and tactics. ASMs can be deadly, even in small numbers, as events during the Falkland Islands conflict demonstrated. Defense against ASMs falls into the area of responsibility of the AAW planner. The main weapon available to aid in this defense is a surface-to-air missile (SAM) called the Standard missile, now deployed on some guided missile cruisers, destroyers, and frigates. Since its introduction, the Standard missile system and its supporting sensors have been continuously upgraded to improve the system's ability to intercept and destroy attacking aircraft and ASMs.

For the AAW planner, the evolution of ASMs, the defensive missiles designed to engage them, and the sophisticated sensors to complement the defensive missiles presents an extremely complex problem. It is the responsibility of the planner to design a formation of AAW ships and aircraft that will

fully exploit their capabilities. To plan and manage an effective AAW defense, the AAW planner must be able to reliably estimate how his defensive systems will fare against the threat. The AAW Tactical Decision Aid developed by CNA is designed to help the planner organize the more technical aspects of AAW and to help him understand the tactical implications of his planning options, and to do so quickly.

The aid, an interactive computer program for use on desktop computers, is intended to help the planner foresee the benefits and risks associated with alternative dispositions of his AAW ships and aircraft. It will not lead the planner toward any particular tactic, since no single tactic will work in all circumstances. Rather, the aid relieves the AAW planner of much of the burden of having to handle the enormous quantities of technical detail that must be taken into account. In this way, the planner is more free to devote his attention to the broader aspects of the feasibility and desirability of his options, so that a sound AAW posture can be arrived at quickly.

NAVAL PLANNING AND MANAGEMENT

The Air Battle of the Future

The AAW problem is expected to grow with time as the Soviet Union enlarges its fleet of Backfire ASM bombers and introduces a follow-on called the Blackjack. Such enemy systems, using electronic warfare techniques in addition to sophisticated antiship missiles, could pose a severe threat to United States forces.

The Chief of Naval Operations asked for a study to determine how the Navy should defeat long-range air threats to United States

maritime forces. The study was done at CNA by a Navy-CNA team. A CNA research program director was appointed deputy director of the study, and many CNA analysts made major contributions.

The focus of the study was on the destruction of the threatening forces far beyond the range of today's AAW forces. The study considered the threat of the years 1990-2000. The assumed threat consisted of those systems projected by the intelligence community and other systems deemed technologically feasible during this century, even if not projected.

The study team examined not only the interaction between enemy weapons and Navy weapons, but also the contributions of surveillance and targeting systems, electronic warfare and countermeasures, and the underlying command, control, and communication system. The surveillance and targeting systems included space-based systems, over-the-horizon radars, and sensors mounted on sea-based and land-based aircraft. Weapon systems included fighter aircraft armed with air-to-air missiles and surface-to-air missiles that were launched from ships.

The study team also considered such exotic systems as high-energy lasers. A variety of electronic warfare techniques and countermeasures were considered for making more difficult the enemy's task of locating U.S. forces.

The study team recommended an integrated approach for fighting the outer air battle. The team stressed the importance of attacking enemy bombers before they launch their missiles, not only to minimize the number of incoming missiles with which the close-in

defenses must cope, but also to discourage further attacks.

Manning the Naval Reserve

The Navy's Selected Reserve (SELRES) is scheduled to grow by a third in the next several years. There has been skepticism about the feasibility of this growth. But there was no firm basis for assessing the adequacy of plans for increasing the size of SELRES because research relating Reserve manpower policies to the flow of people into and out of SELRES had not been done. Nevertheless, the Reserve is increasingly seen as a way to cut the cost of manning the growing Navy.

This study therefore sought to fill the analytical gap and answer important policy questions — how can the Reserve be enlarged and at what cost? The study used statistical procedures to develop quantitative estimates of the effects of economic and other factors on Reserve accession and retention. Particular attention was paid to the relative effectiveness of different Reserve accession programs. The poor state of data on the Reserve made these tasks difficult.

Perhaps the most important finding is that SELRES could be manned more easily and at lower cost by accepting more Navy veterans. It costs less to recruit Navy veterans who have already been trained than to bring in untrained people to fill the junior ranks of SELRES.

Attrition from the Reserve is high. To reduce it, the study team recommended that recruiters be evaluated not on how many Reservists they get in, but on how many stay in. The team

also recommended construction of a screening table for recruiters to use in ranking recruits. This is being done.

Better Resource-Allocation Methods

The Navy's principal mechanism for making resource-allocation decisions is the annual process that leads to the Program Objectives Memorandum (POM). The POM, which is submitted to the Secretary of Defense, shows how the Navy plans to allocate its budgets for the next five years. The first year of the POM forms the basis for the Navy budget that is submitted to the Congress.

To some extent, therefore, the future effectiveness of the Navy depends upon the soundness of the decisions made in developing the POM. And the quality of those decisions depends, in turn, on the documents and procedures that lead to the POM.

One type of document is the "baseline assessment," whose purpose is to ensure that the POM includes adequate support resources and provides a proper balance between current readiness and future capabilities. The baseline assessments estimate the resources needed in such areas as logistics, manpower, and training. They are developed at the beginning of each POM-development cycle and used during the cycle to identify support functions to which funds should be allocated.

In the past few years, the Navy had tried to improve the baseline assessments, but was dissatisfied with the results. In 1983, the Navy asked CNA to conduct an independent evaluation of the baseline assessments and to recommend changes.

The CNA study team found that the quality of information contained in the assessments was not adequate to support the POM development process in the way intended. Units of measure need improvement and should show how support functions relate to combat effectiveness. In addition, baseline assessments try to accomplish two different functions at once, and do neither well. The assessments provide a vehicle for updating the POM data base. They also attempt to identify support issues that require resolution and decision. For various reasons, the data presented in the assessment to update the POM data base are, in many cases, unreliable or incomplete. As a result, the documents can not adequately address support issues and alternatives. Because of these shortcomings, the Navy staff offices that develop and use the baseline assessments have judged these documents to be consistently less useful than other POM documents.

CNA presented its evaluation of the baseline assessments, with alternatives for improvement, to the Navy's Program Development Review Committee – the senior-level group responsible for overseeing POM development. The Committee generally agreed with CNA's findings and, as a result, established a working group to improve the baseline assessments for the next POM-development cycle. The CNA analysts have been asked to help implement the changes by serving as consultants to and members of the working group during the cycle.

The State of the Merchant Marine

Since the end of World War II, the number of U.S.-flag ships engaged in foreign commerce has decreased from 2,277 to a current low

of 175. In contrast, U.S. oceanborne foreign commerce has almost doubled in the last 10 years, from about 470 million tons in the early 1970s to more than 770 million tons. Less than five percent of the total is carried in U.S.-flag ships.

This decline in the size of the U.S. Merchant Marine can be expected to continue. Moreover, most new merchant ships will be built to operate at automated terminals and to carry only one type of cargo. These trends will severely limit the future military utility of the U.S. Merchant Marine.

To reverse the decline of the U.S. merchant fleet, House Resolution 1242 (HR-1242) was introduced before the 98th Congress. This cargo-preference bill would require up to 20 percent of all U.S. bulk foreign commerce to move in U.S.-built and -crewed merchant ships, within 15 years after enactment. The bill's sponsors indicated that the higher costs of building ships in U.S. yards and manning them with U.S. crews would be offset by a 15-percent reduction in shipbuilding costs through series production and by ship designs requiring 15-percent fewer crew members.

CNA was asked by the Assistant Secretary of the Navy (Shipbuilding and Logistics) to lead a study to examine HR-1242: its economic implications, the numbers of new ships it might generate, their size and operational capabilities, and their utility for military sealift. Because it was necessary to establish a Navy position on this legislation before the start of Congressional hearings, the study had to be completed in two months. CNA analysts prepared a detailed study plan and arranged for technical contributions from the U.S. shipping industry, the shipbuilding industry, the Naval Sea Systems Command, and the David Taylor Naval Ship Research

and Development Center. The CNA analysts added these contributions to their own research into the economic effects of the bill and military utility of the resulting ships, then wrote and delivered their report on time.

The study found that a cargo preference bill like HR-1242 could, in fact, add about 300 ships to the U.S. merchant fleet. Most of them would be useful in such military applications as delivery of fuel, supplies, and combat equipment. In addition, the design of the ships could be tailored at a relatively low cost to enhance their military utility without seriously degrading their commercial usefulness.

On the other hand, the study also showed that such legislation would impose significant costs on bulk commodity shippers, even if the 15-percent reductions in construction cost and crew size were achieved.

The results were used in preparing testimony given by the Assistant Secretary to the House Subcommittee on Merchant Marine and Fisheries. The Assistant Secretary also made the report available to the House and Senate Merchant Marine Committees to help their staffs prepare for action on HR-1242.

MARINE CORPS PROGRAMS

Future Amphibious Lift Forces

The assault element of an amphibious force consists mainly of infantry, tank, and artillery units. Their successful landing is critical to the success of an amphibious operation. Two basic landing plans are followed; both plans involve the isolation of a beach (for subsequent force buildup and resupply) by placing forces directly on the beach and at inland positions to block enemy forces moving toward the beach.

In one plan, most of the assault element is placed on the beach, with the remainder placed inland (Beach Primary); in the other plan, most of the assault element is placed inland, with the remainder placed on the beach (Inland Primary). To be able to execute either plan, according to the tactical situation, the Navy and Marine Corps have sought to buy enough amphibious assault vehicles (AAVs) and landing craft to place most of the assault element on the beach and enough helicopters to place most of the assault inland, as well.

Concepts for executing the assault landings envisioned launching AAVs from LSTs close to the beach, while LCACs (air-cushioned landing craft) and helicopters were launched from over-the-horizon. The viability of an operation that required LSTs to come close ashore, in the face of modern surface-to-surface weapons, had been widely questioned. Moreover, as long as AAVs carrying infantry units were expected to be launched close ashore, it was hard to justify the use of LCACs to move tanks and howitzers from ships operating farther off shore.

The simple solution to these criticisms is to land the entire assault element with LCACs and helicopters; but this is a costly solution. Even without a full over-the-horizon assault capability, the cost of amphibious ships and ship-to-shore vehicles was creating pressure to build enough forces to execute only one landing plan. Concerns for the viability of landing plans and for the high cost of amphibious lift led the Office of the Secretary of Defense to direct the Department of the Navy to study its long-term amphibious-lift program.

A CNA analyst played a major role in the Department of the Navy's study. As a result

of the study, the Navy, Marine Corps, and Office of the Secretary of Defense have agreed on a program that allows for over-the-horizon lift of all assault elements, retains the flexibility to execute both basic landing plans, and saves \$2.7 billion.

Having a full over-the-horizon capability at lower cost was made possible by the CNA analyst's key insight: Helicopters can place forces on the beach or inland, depending on the landing plan to be executed. Nevertheless, previous plans had called for helicopters to lift such units inland and for landing craft to take them to the beach. By eliminating the redundant – and expensive – landing craft, less wet-well space will have to be provided in amphibious ships. And fewer – even more expensive – amphibious ships will have to be bought.

Operating Harriers and Helicopters Together

The Marine Corps has periodically deployed a mixed force of AV-8 Harriers and helicopters on board LPH and LHA class amphibious ships. Although LPHs and LHAs were designed for helicopter operations, the AV-8 can also operate on these ships with little difficulty because of its ability to take off and land vertically. The helicopters lift troops and equipment; the Harriers provide air support during landing operations.

The Marine Corps and Navy decided that a test was needed to determine how well AV-8s and helicopters could operate together from the same LHA during an amphibious assault. The Marine Corps was also interested in determining the best number of AV-8s to deploy, along with the standard complement of helicopters.

To carry out the test, a team of CNA analysts assisted the Marines in writing the test plan

and was responsible for collecting and analyzing the test data. One portion of the test examined flight operations during the high tempo of an assault landing; the other portion examined the ability of the LHA to handle the AV-8's ordnance.

The CNA analysts reconstructed the ordnance handling and flight operations. Based on these reconstructions, the analysts estimated how well the operations would have been carried out if the test had not encountered such problems as bad weather and equipment malfunctions.

The reconstructions showed that even in the difficult operating conditions experienced in the test, AV-8s and helicopters could operate with minimal interference from the same deck, at the same time, during the high tempo of an assault landing. In a few instances, AV-8 takeoffs and landings caused short delays in the loading of helicopters, which slightly decreased the rate of movement ashore. Also in a few instances, helicopter operations delayed AV-8s that had been called for air strikes. Most such delays could be avoided through better coordination.

The test revealed some deficiencies in ordnance handling. Several minor modifications to the LHA were recommended that should substantially increase their capacity for assembling and storing AV-8 ordnance.

In general, results of the test were encouraging. Better coordinated flight and deck operations and minor modifications to the LHAs should enable AV-8s to operate effectively alongside helicopters.

Enlistment Bonuses in the Marine Corps

Since 1972, the Marine Corps has offered bonuses to increase enlistments. Through the Enlistment Bonus Program (EBP), some recruits receive a lump sum bonus payment after they complete their training and have been assigned to a military occupational specialty. The EBP has typically distinguished between the Combat Arms Enlistment Bonus (CB) and the Technical Skills Enlistment Bonus (TB). For CB, recruits must be in Mental Groups IIIB or above; for TB, recruits will usually be in the top two Mental Groups (I and II). Both CB and TB require a four-year enlistment and promise, in return, training and assignment to a specific occupational specialty.

CNA's study of the EBP examined the program's effect on the quality of enlistees and assessed the cost-effectiveness of using bonuses to increase the supply of recruits. The study found recruits in the EBP to be of generally higher quality than other recruits. This difference reflects, in part, the EBP's higher qualifications.

Compared with other means of generating increased enlistments, bonuses cost less than the GI bill but more than recruiters or advertising. However, bonuses have an advantage: they can be easily targeted to particular quality groups and particular skills. The technical-skills bonus has been successful in directing people from minority groups into technical areas. The increase in the mental standards for the combat-arms bonus, which was included in the FY 1982 program, should make CB more successful in drawing high-quality recruits into combat

arms. The bonuses have another important advantage in that they induce some recruits to sign up for four years instead of three. This raises the experience level of the Corps and reduces training costs.

The study team found that a large proportion of the funds available for enlistment bonuses was not used. Some potential recruits who had been promised bonuses did not enlist; some recruits were discharged from the Marine Corps before completing their training. Also, technical-bonus funds were underused because of the failure of some recruits to qualify for designated occupational specialties. In general, the proportion of bonus recruits who left the Marine Corps after payment was higher for combat arms than for technical skills.

Because of the ability to target bonuses to particular quality groups and particular skills, and because of the contract-lengthening effect of the bonuses, the study recommended that EBP be continued, with some changes. One of these is to expand the use of the program to bring in more four-year enlistees with technical skills. The study also recommended that requirements for admission to the EBP be strictly followed and that quotas for EBP recruits be set high enough so that all the bonuses are used.

Enlistment Standards and Military Job Performance

In the late 1970s, CNA found that scores on the Armed Services Vocational Aptitude Battery (ASVAB) were seriously inflated. As a result, enlistment standards were inadvertently lowered, and the Services

enlisted many people who would have failed to qualify had the ASVAB scores accurately measured mental aptitudes. When the problems with the scores became widely known, the Congress and Defense personnel managers wanted to know whether the influx of people who should have failed to qualify seriously affected job performance.

A large joint-service research effort was then initiated to determine the relationship between enlistment standards and job performance. CNA's specialists in Marine Corps manpower played a key role by conducting a feasibility study to determine the relationship between job-performance tests, which are expensive to develop and administer, and other measures that are less expensive to obtain, such as training grades and supervisors' ratings. The study also assessed the accuracy of the ASVAB's ability to predict job performance and estimated the cost of developing, administering, and analyzing measures of job performance.

The CNA research effort focused on radio repairers, automotive mechanics, and infantry riflemen. These specialties vary widely in their job requirements. Radio repair is technically demanding; automotive repair, moderately demanding; the infantry is relatively low in its technical demands. For each specialty, Marine Corps job experts developed a hands-on test and a written test. The tests were administered by the Marine Corps to people in each specialty. CNA analyzed the results.

CNA's analysis indicates that for the two technical specialties (radio repair and automotive mechanic) the four measures of performance — hands-on tests, written tests,

training grades, and supervisors' ratings — are highly related to each other. For infantry riflemen, however, only the written and hands-on tests are highly related; training grades and supervisors' ratings had relatively little relationship to scores of hands-on and written tests.

The second objective of the CNA research effort was to evaluate how accurately the ASVAB predicts job performance. If the ASVAB is an accurate predictor, it can be used confidently to set mental standards. The ASVAB did prove to be a valid predictor of performance in all three specialties. People who score high on the ASVAB as a rule perform well on the job, and those who score low on the ASVAB tend to perform poorly on the job. Therefore, the ASVAB is fulfilling its intended function of classifying applicants for enlistment according to their potential job performance.

The third objective of the CNA study was to determine the cost of developing, administering, and analyzing job-performance tests. Developing a hands-on test and a written test for a specialty costs about \$165,000. It costs about \$135,000 to administer hands-on and written performance tests to about 400 examinees. The cost to analyze the performance measures and the ASVAB is about \$60,000. The total cost is \$360,000 or about \$1,000 per examinee. The one-time cost to test Marines in 50 selected specialties would be more than \$20 million.

CNA concluded that it is feasible to relate mental standards to job performance, but questioned the need for widespread job-performance testing simply to validate mental standards. The CNA study, although

limited to three specialties, supports continued use of the ASVAB to set mental standards for recruits.

FIELD OPERATIONS

Evaluating the Realism of Exercise Jamming

Major fleet exercises may continue for days or even weeks, and they sometimes involve the combined forces of several battle groups. Their purpose is to train personnel, evaluate systems, and develop tactics under conditions as close as possible to combat. Because of the high cost of these exercises, they are relatively infrequent. Consequently, both operators and analysts must be able to take full advantage of every exercise that is conducted. This means that the exercises must be as realistic as possible, for purposes of training. Also, it means that analysts must be able to adjust for any unavoidable artificialities when using exercise data to evaluate new systems or tactics.

CNA analysts, because of their direct involvement in the design, reconstruction, and analysis of at-sea exercises, have long played a role in helping the fleet identify exercise artificialities and account for their effects. This past year, CNA initiated a long-term project with these same general objectives. The project was an outgrowth of CNA's involvement with the series of readiness exercises that take place several times a year in the waters off Puerto Rico. One of its first products, and the one that will be highlighted here, was an analytical method for evaluating the realism of jamming in exercises. This method was used by CNA field representatives during their shipboard

reconstruction and analysis of the hostilities phase of a readiness exercise held in March 1983.

During the March exercise, as in many other exercises with similar objectives, a large force of aircraft simulated attacks by Soviet bombers on an aircraft carrier and its escorts. The outcomes of such engagements would depend in large part on which side makes best use of the electromagnetic spectrum. The surface ships use jamming and other electronic countermeasures in an attempt to prevent the bombers from locating and targeting the carrier at long standoff ranges. Similarly, the bombers are accompanied by jammer aircraft whose goal is to prevent air-defense ships and sea-based fighters from determining the exact location of the incoming raid or destroying its missiles in flight. Analysts can usually reconstruct the simulated attacks that each side is able to conduct during one of these encounters. However, without some measure of whether the jamming was realistic, it can be difficult or impossible to draw inferences about actual capabilities from exercise results.

In their analysis of the March exercise, the CNA analysts focused on evaluating the contribution of the jammer aircraft that accompanied the bomber raids. There, two factors affected the realism of the exercise jamming. The first was that jamming systems on U.S. Navy aircraft are not necessarily similar to those that the Soviets might employ, and the second was that the exercise jammers could operate much closer to the battle group than would be prudent for Soviet aircraft. Using programs developed in CNA-Washington, the analysts were able to calculate the difference between the jamming

levels actually obtained in the exercise and those that would have resulted from the systems and tactics that Soviet aircraft are estimated to employ. Their method took into account the relative placement of the jamming aircraft and the victim radars, as well as the effects of operator proficiency and the electromagnetic environment of the exercise area. It yielded a quantitative measure of jamming realism that could then be used to translate exercise results into estimates for the outcome of an actual engagement.

In addition to providing the fleet with a yardstick for gauging the results of a particular exercise, the CNA analysts were able to determine equipment modifications and tactical improvements that would permit more realistic jamming in future exercises. Moreover, because the CNA programs will be made available to the analysts who reconstruct those exercises, the fleet can receive rapid feedback on the effects of any changes. Eventually, this repeated modification and verification should greatly improve both the value of exercise training and the usefulness of exercise data.

Towed-Array Sensors in Operation

Passive and active acoustic sensors are the primary means by which surface ships search for enemy submarines. Passive acoustic sensors depend on the noise radiated by the submarine as part of its normal operations. To work efficiently, these sensors must discriminate against noise not associated with the submarine target. This extraneous noise may come from waves, rain, surface ships, marine life, and many other sources. The need to discriminate against these noise sources while searching for submarine-radiated

noise has led to the development of towed arrays consisting of a line of acoustic listening devices whose sensitivity is electronically steered to the appropriate sounds.

This technology was first applied operationally in 1976, when the engineering prototype for the SQR-18A Tactical Towed Array Sonar (TACTAS) began operating in the Atlantic Ocean and Mediterranean Sea. At the same time, CNA began to participate in the tactical development of TACTAS by supplying on-scene analytical support to the Navy during the initial deployment of the prototype. The SQR-18A is now deployed and is the primary passive acoustic sensor aboard 1052-class frigates. Meanwhile, CNA's support has continued, and has led to the publication of three assessments of TACTAS's operational performance and a study of TACTAS's performance in exercises and operations between 1976 and 1981. The primary topics of this study are the ability of TACTAS ships to detect, identify, maintain contact on, and accurately pinpoint the location of submarines.

The SQR-19 TACTAS, an advanced design, is now entering the fleet. CNA has developed a computer simulation to help find the best station for this array within a battle group. This simulation is being used to study the effect of battle group noise on the performance of the SQR-19 TACTAS, as the ship towing the array is stationed at various ranges from the battle group's main body. Battle-group noise increases as the array ship is stationed closer to the battle group, making it more difficult for the array to hear the "noise signature" associated with an enemy submarine. As the array ship is moved away from the battle group's main body, the noise decreases. But moving the array ship away from the battle group diminishes the array ship's ability to perform another mission — anti-air warfare defense of the battle group. Whether the enemy submarine is armed with

torpedoes or missiles also has an influence on the stationing of the array ship. CNA is examining the tradeoffs involved in alternative array ship stations, which is expected to lead to the development of appropriate tactics.

PUBLIC RESEARCH INSTITUTE

Price Controls and Petrochemical Markets

During the last decade, most energy products — crude oil, natural gas, gasoline, and other refined products — were subject to price controls. Though some of these controls have been lifted, the Common Market countries have complained that the price controls subsidize U.S. exports of energy products, particularly petrochemicals. The Bureau of International Labor Affairs of the Labor Department asked PRI to analyze the effects of the price-control programs.

PRI considered whether the price controls did, in fact, subsidize petrochemical exports and, if so, by how much. The results should help policy makers predict how markets will be affected by the further removal, or reinstitution, of price controls.

The key issue for analysis was whether the controls affect the price of marginal units of crude oil and natural gas. It is the price of marginal units of an input (crude oil and natural gas) that determines the supply of an output (petrochemical). When the crude oil controls began in 1973, they did not affect the marginal price of crude; the marginal price remained the world price. However, the entitlements program that began in 1974 did influence the marginal price of crude and, therefore, the supply of petrochemicals.

Briefly, the entitlements program made price-controlled "old oil" available to all U.S. refiners. The net result was to spread

the "windfall profit" to refiners who had been using only imported crude, thus reducing their marginal cost and the price of refined products. For natural gas, the price regulation that split the U.S. market into a controlled market and an uncontrolled market also lowered prices.

These "subsidies" to U.S. refiners would have been passed along to foreign producers of petrochemicals to the extent that U.S. refiners sold intermediate products to foreign producers. The extent of such trade varied by product: Exports were 10-20 percent of the production of some intermediates; other products showed no trade. Evidently, trade did not negate the "subsidies" to U.S. refiners.

On balance, however, the advantage to U.S. refiners was small. U.S. petrochemical output increased by less than five percent as a result of price controls, while foreign production decreased by less than three percent. Price controls did not significantly undercut foreign producers of petrochemicals; the removal of price controls will not lead to a major, long-term decline in the U.S. petrochemical industry.

Older Workers and Part-Time Employment

Economic theory and responses to surveys suggest that most older workers would retire gradually, by taking part-time jobs, rather than all at once. But sudden retirement is the norm: Among white males, for example, 77 percent work full time at ages 55-61, compared to 37 percent at ages 62-64; 85 percent of those who stop working full time stop working altogether.

The National Commission for Employment Policy asked PRI to study this apparently

anomalous behavior and to determine its policy implications, if any. PRI concluded that employers, in general, find part-time workers to be more costly per hour than full-time workers. As a consequence, workers will be offered a lower hourly rate if they work part time than if they work full time. For older workers, the lower hourly rate is less appealing than full retirement.

The implication of this finding is that the lack of part-time employment among older workers is not generally due to discrimination on the part of employers. Policies aimed at reducing or eliminating such discrimination would have little effect on the number of older persons who work part time.

Other policies that might encourage more part-time work were also analyzed: (1) a reduction of the employment cost by reducing or eliminating government-mandated costs (e.g., employer contributions to Social Security), (2) removal of the Social Security earnings limit, and (3) a subsidy for hiring older workers. PRI found that these policies would not affect the retirement decision of a typical worker; retirement would be sudden in any case because hourly compensation is enough lower for part-time work to discourage any but full-time work.

In sum, so few older workers hold part-time jobs simply because they do not pay well. The low pay for part-time work is general, it is not restricted to older workers. (Part-time work is concentrated among married women and students because they have other commitments that generally preclude full-time work.) There is no obvious reason to believe that older workers are kept out of this market or that they would be better off if Federal policy were to change.

III. Personnel

A continuing objective of CNA's management is the recruitment, retention, and development of a high-quality research staff. Every year, CNA's managers devote considerable time toward achieving this goal. This section briefly profiles the research staff and outlines some of CNA's personnel management policies.

RECRUITING

CNA's college recruiting program is directed at the most prestigious institutions in the country. Recruiting at conventions and professional society meetings supplements the college program to bring CNA in contact with both new and experienced talent from a variety of academic disciplines. These activities are augmented by advertising and search programs designed to attract senior professionals with outstanding credentials in the field of defense analysis. This table shows the source of hires for CNA's professional staff in the past five years.

PROFESSIONAL STAFF RECRUITING

(1979-1983)

<u>Source of hires</u>	<u>Percent</u>
University (student)	30
Private industry	26
University (faculty or staff)	25
Federal government	12
Non-profit organization	6
Military	<u>1</u>
Total	100

STAFF COMPOSITION

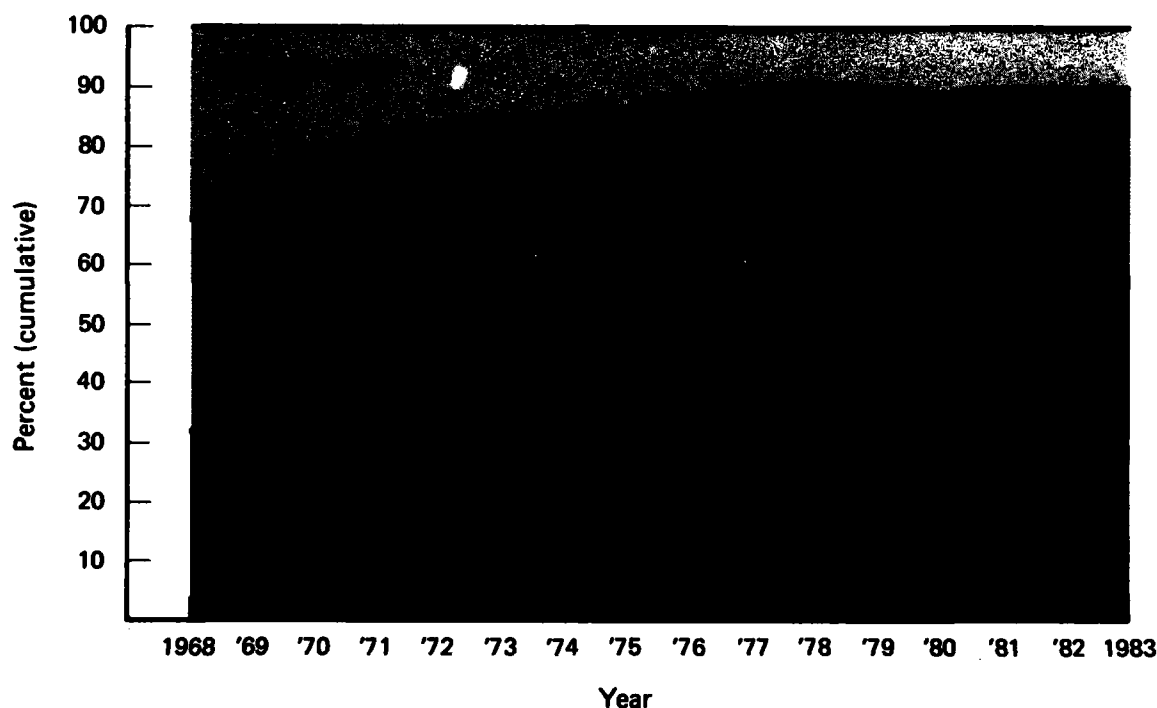
A great deal of attention has been directed at building the academic credentials of CNA's professional staff. Progress in this regard is reflected by the change in the proportion of the staff holding graduate degrees (see page 24).

The large fraction of staff members with advanced degrees gives CNA an important advantage in conducting detailed, thorough research and performing tasks in the field. The table on the next page compares the educational credentials of CNA's staff with those of similar research organizations.

CNA also takes pride in the practical experience of its staff; operational experience with the fleet is an essential ingredient of relevant planning studies for Navy offices in Washington. Almost half of CNA's research staff has spent one or more tours in field assignments at Navy and Marine Corps commands, where they have acquired first-hand knowledge of the forces, systems, and operations they are called upon to analyze at CNA-Washington. Researchers with field experience have spent, on average, 3.1 years in the field.

More generally, the research staff's professional work experience averages 13.9 years, with 10.1 years of that in defense research. The staff's experience, combined with postgraduate education that averages 4.6 years, sets CNA apart from most organizations in the credentials that its staff brings to bear on significant national defense issues.

RESEARCH STAFF DEGREE LEVELS (1968-1983)



POSTGRADUATE DEGREES

(Proportion of Professional Staff, 1983)*

	<u>Doctor's</u>	<u>Master's</u>	<u>Total</u>
Center for Naval Analyses	60%	30%	90%
16 Contract Research Centers	29	33	62
32 Federal Research Laboratories	17	20	37
48 Profit-seeking firms	16	27	43

*Source for other institutions: "National Survey of Compensation Paid Scientists and Engineers Engaged in Research and Development Activities," Battelle Memorial Institute, Columbus, Ohio, November 1982. Data for 1983 are unavailable as of this printing, but the proportions for other institutions have changed little in recent years.

The diverse nature of CNA's research program requires a mix of academic disciplines. These are the disciplines represented in the research staff:

	<u>Percentage of staff</u>
Physics and chemistry	28
Mathematics and statistics	20
Economics, business, and finance	18
Engineering	12
Operations research	7
Psychology and sociology	3
History	3
Political science and international relations	3
Other	<u>6</u>
Total	100

SALARIES

The Senior Vice President and Department Directors approve all offers of employment and all actions affecting research staff salaries. Any salary above the basic pay authorized for Level IV of the Senior Executive Schedule must also be approved by the CNA Board of Overseers and by the Navy's Contracting Officer.

To make sure that CNA salaries are competitive, CNA's management analyzes salary survey data drawn from a large national sample of scientists and engineers by degree, specialty, and level of experience. This information is supplemented by informal exchanges with organizations conducting research similar to CNA's. Individual salaries and research accomplishments are reviewed every year.

EQUAL OPPORTUNITY

CNA has long supported the principle of equal opportunity, regardless of race, creed, color, national origin, sex, age, physical handicap, or veteran status. To that end, CNA has established policies and practices in conformity with federal legislation. The main objectives of CNA's Affirmative Action Program are: (1) to make sure that, within each sector of the labor market drawn on by CNA, minorities and women are represented on the CNA staff to the same degree as they are in the sector as a whole, and (2) to provide all employees with opportunities for training and advancement. CNA continues to be dedicated to these objectives.

IV. Finances

CNA operates as a division of the Hudson Institute, a not-for-profit New York corporation. All contracts, bank accounts, and other legal agreements are carried in Hudson's name and are executed by designated officials of the Hudson Institute.

FUNDING

Cost-reimbursable contracts with the Department of the Navy (DoN) accounted for 98 percent of CNA's funding during FY 1983. Small contracts and grants with other government agencies accounted for the remaining 2 percent. On DoN contracts, the Hudson Institute charges a 2-percent fee, all of which is committed to the performance of long-range studies of interest to the Navy.

CASH REQUIREMENTS

Because CNA lacks other sources of capital, the organization's contracts call for the Navy to provide working capital through an advance funding account. Advances are drawn twice a month on the basis of anticipated expenditures and offset by monthly vouchers.

FINANCIAL CONTROLS

Financial control of CNA's operation is achieved through a system of budgeting and expense monitoring. At the start of the fiscal year, an operating budget is developed for each division and department within CNA. They must then perform their assigned tasks within that budget. Monthly expenditures are monitored closely, and budgets are revised whenever there is a significant change in CNA's funding.

All contract expenditures are reviewed by the staff of the Vice President for Finance and Administration, to ensure compliance with federal regulations and contract provisions. Expenditures for travel, supplies, equipment, and consultants are documented by requisitions and approved by CNA's management. Major purchases must be approved in advance by the Navy's Administrative Contracting Officer. CNA's financial system is also audited regularly by the Defense Contract Audit Agency and Hudson's public accountant (Arthur Anderson).

STATEMENT OF COMPARATIVE FINANCIAL CONDITION

30 September 1983 and 30 September 1982

ASSETS

	<u>1983</u>	<u>1982</u>
Current assets		
Cash	\$ 801,458	\$ 43,636
Receivable (note 1)	255,299	109,491
Travel advances and prepaid items	221,766	437,882
Advances — U.S. Navy	<u>—</u>	<u>644,733</u>
Total current assets (note 2)	<u>\$1,278,523</u>	<u>\$1,235,742</u>

LIABILITIES AND RESERVE FOR DISALLOWANCES**Current liabilities**

Advances — U.S. Navy	\$ 16,646	\$ —
Accounts payable	465,992	215,120
Payroll taxes and other withholdings	<u>7,437</u>	<u>165,653</u>
Total current liabilities	490,075	380,773

Other liabilities

Accrued annual leave	\$ 788,448	\$ 801,064
Unbilled labor adjustments	<u>—</u>	<u>53,905</u>
Total other liabilities	<u>788,448</u>	<u>854,969</u>
Total liabilities	<u>\$1,278,523</u>	<u>\$1,235,742</u>

NOTES:

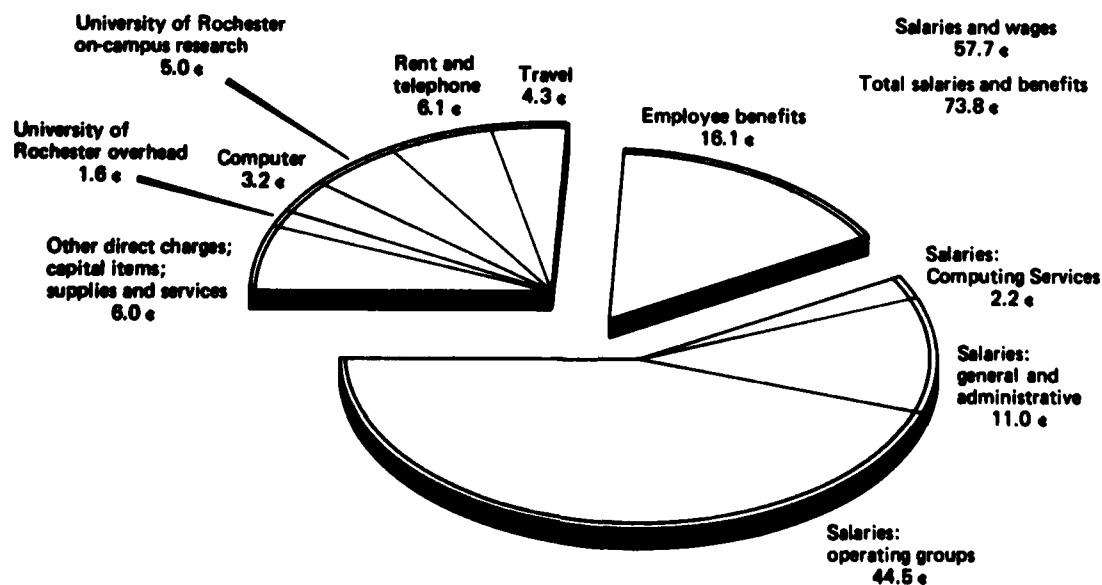
1. Government agencies account for over 95 percent of all receivables.
2. CNA has no physical assets. Property and equipment constitute direct charges, with title vesting in the government.

FUNDING IN FY 1983
(Thousands of Dollars)

Source of funds:	CNO/CMC Study Program	\$ 15,181
	Tactical Development and Evaluation	3,205
	Other Defense Programs	<u>958</u>
	Total FY 1983 funding	19,344
	Funds carried forward from FY 1982	<u>1,848</u>
	FY 1983 total funds available	<u><u>\$ 21,192</u></u>
Application of funds:	CNA program costs	\$ 20,226
	On-campus research*	<u>966</u>
	Total funds applied	<u><u>\$ 21,192</u></u>

*CNA was managed by the University of Rochester through 30 September 1983. The University applied 5 percent of CNA's funds to on-campus research, in lieu of a management fee.

**APPLICATION OF THE RESEARCH DOLLAR
IN FY 1983**



END

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