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This is a final report of the comittee that reviewed Navy's management and planning of ADP systems. Committee recommends new thrust that focuses on information rather than transactional ADP systems; change ADP systems into information systems. The following specific recommendations were made: The Navy needs a strong advocate of information systems at Chief of Naval Operations-level (CNO), Create a new CNO division, Information Systems Division, under a flag officer to report to Command and Control. Naval Data Automation Command (NAVDAC) to report to this division, Retain current reporting structure of Naval Regional Data Automative Centers (NARDACs), under NAVDAC: do not place NARDACs under Naval Material Command (NAVMAT), Create a new division under flag officer within NAVMAT to direct and coordinate all information functions, Transfer Navy's ADP acquisition agent, the Automatic Data Processing Selection Office to NAVMAT. This report also describes how well the Navy has implemented the committee's recommendations.

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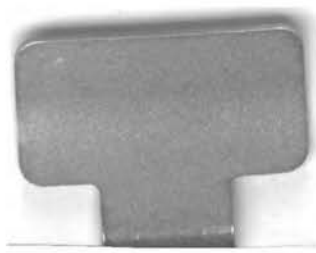

Navy Information Systems: Planning, Policy, Organization, and Management

Final Report to the United States Navy

Committee on Review of Navy Long-Range ADP Planning

Board on Telecommunications and Computer Applications
Commission on Engineering and Technical Systems
National Research Council

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This report has been reviewed by a group other than the authors, according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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PREFACE

This is the final report of the committee assisting the Navy review its management of information systems. The committee reviewed how well the Naval Data Automation Command (NAVDAC), established in 1977, had corrected the reported deficiencies in Navy information systems. The report provides a basis for a major effort by the Navy to improve management by taking advantage of the emerging information systems technologies.[1/]

The committee was appointed in April 1982 by the National Research Council (NRC) Board on Telecommunications and Computer Applications (BOTCAP), at the request of the Vice Chief of Naval Operations (VCNO) to the Chairman of the National Research Council, Commission on Engineering and Technical Systems (formerly the Assembly of Engineering). The committee was asked to review Navy information systems policy planning, information requirements, and the management and organization of those responsible for the Navy's information systems. The Navy also expressed a need for guidelines to help it develop a comprehensive set of requirements for Navy management of nontactical information systems in the 1980s and 1990s and for long-range planning of information systems architectures.

On 22 and 23 July 1982, at the first meeting of the committee, the Honorable Robert H. Conn, Deputy Under Secretary of the Navy (Financial Management [ASN(FM)], and Admiral William N. Small, then VCNO, stated that the Navy expected to receive advice, guidance, and recommendations on how the Navy should solve its fundamental problems with automatic data processing (ADP), including inadequate data bases, poor projections of requirements, and data that were not progressively distilled as the data move up the chain of command. In addition, few Navy officials were thought to understand how ADP fit into their functions or even its potential for improving mission effectiveness. The VCNO also asked the committee to recommend management and operating adjustments that the Navy could make in the short term to improve the effectiveness of current ADP operations.

During the first six months of study, the committee held six two-day meetings and then briefed the VCNO on tentative findings and conclusions on Navy ADP policy, organization, and management.[2/]

The committee met six times more in 1983 and also held a workshop at the Naval Postgraduate School in Monterey, California, from 17 February

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[1/]The committee review was a key point in the Navy's response to, "A Report to the Committee on Appropriations, U.S. House of Representatives, on the Effectiveness and Operations of the Naval Data Automation Command," Surveys and Investigations Staff, May 1981.

[2/]The briefing was the basis for Navy Nontactical Automatic Data Processing Policy, Organization and Management (Interim Report to the U.S. Navy), National Academy Press, Washington, D.C., July 1983.

through 6 March. There the committee reviewed and reaffirmed its tentative findings and conclusions and further developed its positions on architecture, planning, acquisition, and organization. At the end of the workshop, the committee briefed the VCNO on additional tentative findings and conclusions.3/

Navy liaison team members were present at the twelve committee meetings, the committee briefings to the VCNO, the committee visits to the four Navy field installations, and the workshop. Privy to committee discussions, and participating when requested, the Navy team was kept informed of the status, progress, and plans of the committee. As a result, the Navy has already taken several actions that top-level managers believe are in line with committee opinions. The committee and the BOTCAP staff alerted the Navy that, at every point in the study before the NAS review procedures were completed, committee findings and recommendations were tentative and subject to change.

The committee in its Interim Report pointed out weaknesses on the part of the Navy in effective information systems use. The committee rarely found clear statements of information requirements on which systems might be based. Although the committee did find scattered instances of advanced system applications, the overall development of information systems technology has been so sweeping and rapid that the Navy -- like most large organizations -- has simply been unable to keep up. Similarly, the Navy's planning process was found to be weak, outmoded, and improperly organized or managed. The Interim Report recommended shifting the management emphasis on procuring ADP hardware and software toward the more effective handling of information as a critical resource. This new emphasis would consolidate and refocus information-related activities at the level of the CNO. These changes would be reflected throughout all major commands in the Navy.

As of this writing, all the principal recommendations of the Interim Report are being implemented at the CNO level. But to present clearly the full scope and rationale of recommendations, this report intentionally disregards the commendable progress the Navy has made to date in implementing the needed changes.

Although not all the discussion and rationale set forth in the Interim Report will be repeated in this report, subsequent analysis has confirmed the need for the recommended changes in the way the Navy deals with its information systems. This analysis has also led to establishing the three areas deemed fundamental to the success of the recommended change: (1) technology, (2) planning, and (3) organization and management.

3/ Selected Working Papers from Monterey Workshop on Navy ADP, National Academy Press, Washington, D.C., June 1984.

This final report of the committee is based on the following:

- The review of over 180 documents from the Navy and other sources.

- Presentations from, and discussions with, more than forty Navy activity groups. The committee also heard from the president of the Computer and Business Equipment Manufacturer's Association, the officer in charge of the U.S. Air Force base-level automation program, the principal investigator of the Surveys and Investigations Staff, who was also one of the two principal authors of the House Appropriations Committee (HAC) report, and the Deputy Assistant Administrator for Information Resources Management in the General Services Administration (GSA).

- Committee visits to four major Navy field installations -- Mechanicsburg, Pensacola, Norfolk, and San Diego -- where personnel described their activities, discussed their problems, and participated in discussions with the committee members.

This report is divided into seven chapters and an executive summary.

- Chapter 1 reviews a series of previous studies and demonstrates that the problems of Navy information systems have been recognized for many years. The committee concludes that old prescriptions will not solve these problems. A new thrust is described by which the Navy can achieve major improvements in the management of its information systems.

- Chapter 2 provides a comprehensive analysis of the part that technology plays in the information systems of the Navy. The Navy must be able to keep up with the technological advances in information systems if it is to carry out its missions effectively. Navy missions drive the need for information systems, and technology provides feasibility and efficiency in the operation of such systems.

- Chapter 3 finds that planning for Navy information systems has been primarily an exercise in estimating how many pieces of hardware will be needed. This chapter takes the theme that planning for Navy information systems must take place alongside the planning for Navy missions. The chapter shows examples of good and bad planning for Navy information systems.

- Chapter 4 finds that there has been little management and organization for information systems at the level of CNO. The mode of most Navy information systems has been decentralization. Only gradually is top management recognizing how critical the Navy's information systems have become to combat readiness: The Navy can only be as strong as its information systems. This chapter gives examples of how information systems could be organized and managed with reasonable representation at the level of the CNO.

- Chapter 5 studies the organization and operation of the NARDACs. In particular, evaluation is made of relationships between the NARDACs, the field commands, and those responsible for Navy information systems at the level of the CNO.

- Chapter 6 responds to a request that the committee provide its views regarding the development and use of information systems architectures. We see the development and use of architectures as an excellent strategy for the management and planning of Navy information systems.

- Chapter 7 shows that, as of this writing, the principal recommendations of the committee's Interim Report are already being implemented at the CNO level. Examples are shown in this chapter.

The committee is pleased to see that the Navy's changes have taken place in parallel with the study. We feel that such efforts recognize and implement the new thrust described in Chapter 1.

The support the committee received throughout the study from the Navy's military and civilian personnel, especially its liaison team, was far more than the committee expected. We are, therefore, deeply appreciative.

The committee also appreciates the efforts of the NRC professional staff, Richard B. Marsten, BOTCAP Executive Director and Jerome D. Rosenberg, BOTCAP Senior Staff Officer and Study Director, and the NRC administrative staff, Carmen A. Ruby and Lois A. Leak.

Dr. Vincent V. McRae
Chairman

EXECUTIVE SUMMARY

This report presents the findings of an eighteen-month study by the Committee on Review of Navy Long-Range Automatic Data Processing Planning, on the Navy's nontactical ADP policy, organization, and management requirements for the late 1980s and early 1990s. Begun in June 1982, the study was undertaken at the request of Admiral William N. Small, USN, then Vice Chief of Naval Operations, as one part of the Navy's response to a critical report issued in 1981 by the Surveys and Investigations Staff of the U.S. House of Representatives Committee on Appropriations.

Nearly every action of a commander, manager, or administrator involves the acquisition and understanding of information. Automated handling of information is a means to store, communicate, and display this needed information clearly. The information should be provided quickly, inexpensively, and efficiently.

In recent years, information systems have pervaded the Navy, as they have other large organizations. They are now integral to Navy operations and will become even more so by 1990. Word processors facilitate writing and editing. Automated accounting systems collate data and compile and display status reports. Terminals, personal computers, and office automation systems bring data directly to the person who needs it. And ADP provides the data for many of these operations. All these systems engage users in a common enterprise: Handling information that is of common concern. In addition, the sweep of technology is rapidly merging these systems. A drive toward compatibility and interoperability between and among the systems can bring about major improvements in Navy efficiency and mission accomplishments, but only if the Navy organizes and plans strategies to manage information effectively.

Yet problems of coordinating these information systems have outstripped the time and attention that management can give to them under the present organization.

It is clear the Navy needs a positive approach -- a new thrust -- to make the most effective use of information as a resource necessary to the life of Navy missions.

In preparing for the 1990s, upper echelons in the Navy must address the effective use of information as a resource. Upper echelons must provide a framework of policy that encourages managers and commanders to define their needs for information and exploit modern technology. Upper echelons must understand the capabilities and potential of information technologies to improve efficiency, economy, and readiness of all Navy activities. They must provide leadership and planning in the development and improvement of information systems as integral parts, not just adjuncts, of the missions they support.

Policies must ensure adequate support for information systems in the Planning, Programming and Budgeting Systems (PPBS) cycle. They must

ensure in the Navy a body of expertise to which commanders and managers can turn for advice, guidance, and assistance in the technical aspects of information management. And they should be designed to control only those elements of implementation that must be controlled at top level.

Success with the new thrust will not come easily. Information-handling tools are evolving at a phenomenal rate. Problems are further compounded by the federal bureaucracy's emphasis on detailed management and control of ADP hardware. Controlling ADP hardware, however, is not the real problem.

Findings

In 1977, the Navy began taking steps to resolve its own conflicts in handling data. By reorganizing nontactical ADP under the Naval Data Automation Command (NAVDAC), it has made commendable improvements in the implementation of new ADP capabilities, cooperation between the user and developers of ADP, and management of the computing facilities. Relationships with the General Services Administration and development of data processing standards have also improved.

But much remains to be accomplished with traditional ADP.

The Navy has little recognition of the value of ADP in supporting day-to-day operations, nevertheless, there is progress in bringing ADP equipment and services up to modern standards. Limited budgets and strictly mandated procedures are the perceived problems, but the Navy has yet to address the importance of information resource management.

Nonetheless, since its inception in 1977, NAVDAC has provided important and needed staff support to the Office of the Chief of Naval Operations (OPNAV). Its field operations effectively and efficiently provide uniform computing services, and its growing technical expertise is valuable to Navy components requiring advice and guidance. NAVDAC technical field operations, housed in the Naval Regional Data Centers (NARDACs), are taking on increased responsibilities as the Navy's information systems shift to a less centralized and more interconnected network. And although the NARDACs have made substantial progress under NAVDAC, the current program to improve the NARDAC facilities and staff will further increase service, while keeping a lid on costs.

But today, too many Navy installations are operating with obsolete computing equipment. This gives rise to many operational problems and denies the Navy the opportunities to take advantage of more efficient and less costly modern software. Indeed, Navy developers and users of ADP systems are discontented and impatient with the slowness with which the new capabilities are brought in. Nevertheless, they are willing to work around limitations and are dedicated to mission accomplishment.

Information-handling systems -- conventional ADP, word processors, personal computers, and data communications -- treat and exchange information and need to be coordinated. Yet the Navy organizations

responsible for the various forms remain separate. This has led to some missed opportunities for improving efficiency and planning for integrated systems in the future. Personal and desk-top computers, for example, are in wide use but are subject to minimal review and coordination within the Navy.

There are several problems in the Navy's process of defining ADP requirements, planning, and relating information requirements to mission requirements. During long planning and acquisition delays, both mission and ADP needs often change. The planning process would be more effective if the developers and users were in the same organization; otherwise planning works less well.

Throughout the Navy there is a lack of architectural planning for information systems. By its very nature, architectural planning cuts across all existing organizational boundaries, so it must be planned for at high levels. Regardless, mission responsibility for ADP has been given a relatively low priority, relegated to a division of OPNAV that has responsibilities besides technical systems. And responsibility for information systems is currently at too low a level; the importance of an advanced information system is not particularly well recognized at top levels.

Recommendations

The committee has the following recommendations for the Chief of Naval Operations:

1. Convert the Navy's archaic ADP systems into well-coordinated and planned Navy information systems (NIS). This change dictates the need to make organizational changes at the Chief of Naval Operations (CNO) level. A strong advocate in OPNAV, responsible for improving training and management, would be necessary to strengthen the role of the NAVDAC. Planning for new information systems would have to be top down, bottom up, and sideways.

2. Create a new division, Information Systems Division (OP-945), under a flag-rank officer reporting to Command and Control (OP-094) in OPNAV. Having sole responsibility for Navy information systems, OP-945 would assure much-improved coordination and assistance to the increasing number of data users. This division would integrate technology from conventional ADP, word processing systems, personal computers, and data communications. NAVDAC would report through this new consolidated division, under the CNO.

3. Retain the current reporting structure of the NARDACs, under NAVDAC. With its missions and functions strengthened, NAVDAC can grow into a center of technical expertise and support to field activities for the entire Navy. To improve the quality of support to Navy organizations, the technical staff should develop new computer applications that employ distributed

equipment, personal computers, and office automation systems. With proper funding, NAVDAC can inaugurate demonstration and prototype projects, test and evaluate new approaches, and adapt new technologies into productive applications, both uniform and compatible. Complementary actions should be taken to improve NARDAC's physical facilities and extend the Naval Industrial Fund (NIF) transition period to two or more years.

The committee has the following recommendations that involve the Chief of Naval Material:

1. At the echelon below the Chief of Naval Material (CNM), there should be an office with a flag-officer billet to direct and coordinate all functions of Navy information systems related to the Naval Material Command (NAVMAT). With the authority of the CNM, this new office can integrate, guide, and direct the structure of the information systems of all field commanders. As at the OPNAV level, word processing and report control should be transferred to the new office.

2. Transfer the Navy's ADP acquisition agent, the Automatic Data Processing Selection Office (ADPSO), a component of NAVDAC, to NAVMAT. With this shift, greater use should be made of the Program Manager (PM) concept for major systems projects. All new computer installations should have provisions for upgrading existing software and equipment.

In sum, a new and greater focus on information, in all its forms, including conventional data processing, would greatly improve the efficiency and effectiveness of meeting Navy missions and functions. To provide the integrated designs and assure the interoperability of existing and new systems, the Navy must begin to think in terms of information systems, not ADP, and to plan and design these new systems from this perspective. Ushering in a new era of excellence, however, requires support at the highest organizational levels and a new spirit of cooperation among all Navy organizations.

If current technology is to support decisionmaking at many levels in the Navy, planning must be better structured, involve senior officials and decisionmakers more intimately and extensively, be more coherent, provide top-down guidance as well as reflect "bottom up" and "sideways" activities, and examine explicitly issues related to the interfaces of systems being developed and operated by organizations at the decisionmaking level.

ACRONYMS

ADP	Automatic Data Processing
ADPSO	Automatic Data Processing Selection Office
AIS	Automated Information Systems
ASN(FM)	Assistant Secretary of the Navy (Financial Management)
BOTCAP	Board on Telecommunications and Computer Applications
CBEMA	Computer and Business Equipment Manufacturer's Association
CDA	Central Design Activity
CHNAVMAT	Chief of Naval Material
CNET	Chief of Naval Education and Training
CNM	Chief of Naval Material
CNO	Chief of Naval Operations
DCNO	Deputy Chief of Naval Operations
DCNO/DMSO	Deputy Chief of Naval Operations or Director, Major Staff Office
DDN	Defense Data Network
DPPSD	Data Processing Programming Support Department
DMSO	Director, Major Staff Office
DON	Department of the Navy
DON/ADPM	Department of Navy Automatic Data Processing Manager
DPI	Data Processing Installation
DPSC	Data Processing Service Center
DSARC	Defense Systems Acquisition Review Council
DUSN (FM)	Deputy Under Secretary of the Navy (Financial Management)
DOD	Department of Defense
EPA	Extended Planning Annex
FYDP	Five-Year Defense Program
GAO	General Accounting Office
GSA	General Services Administration
HAC	House Appropriations Committee
HQNAVMAT	Headquarters, Naval Material Command
IS	Information Systems
ISP	Information Systems Plan
ISSP	Information Systems Support Plan
MAPTIS	Manpower, Personnel and Training Information Systems
MAT-09B	Director, Information Systems and Administration (NAVMAT)
MPT	Manpower, Personnel, and Training (OP-01)
NARDAC	Naval Regional Data Automation Centers
NARF	Naval Aviation Repair Facility
NAVAIREWORKFAC	Naval Air Rework Facility
NAVAIRSYSCOM	Naval Air Systems Command
NAVDAC	Naval Data Automation Command
NAVFACENGCOM	Naval Facilities Engineering Command
NAVMAT	Naval Material Command
NAVSEA	Naval Sea Systems Command
NAVSUP	Naval Supply Systems Command
NAVTELCOM	Naval Telecommunications Command
NBS	National Bureau of Standards
NIF	Naval Industrial Fund
NIS	Navy Information Systems
NMC	Naval Material Command
NRC	National Research Council
NTADP	Nontactical Automatic Data Processing

I. NEEDED: A NEW THRUST FOR MANAGING NAVY INFORMATION SYSTEMS

Since 1966, congressional and internal studies of Navy ADP have covered the same territory, found the same problems, and recommended the same solutions. The principal findings of these studies maintain that

- o The Navy's management of information systems is unstructured and highly decentralized.
- o Navy information systems policy is not enforced.
- o Local management has too much authority over systems efforts.
- o Too much effort is duplicated in developing systems.

A 1966 study initiated by the Special Assistant to the Secretary of the Navy[4/] and a 1975 GAO report[5/] reached the same conclusions. One year later, the same conclusions were found in the Nance Report, the final report of a 1976 study[6/] initiated by the Assistant Vice Chief of Naval Operations. This final report recommended that the Navy establish a new flag-rank ADP command to support the upper-echelon Navy management, coordinate all standard Navy ADP programs, and provide users with technical assistance in developing ADP plans and processing support on a geographic basis.

The Nance Report also recommended establishing an implementation study group to initiate the planning for the new ADP command. So under the leadership of Rear Admiral P. K. Cullins, the group convened on 19 July 1976. Its final report of 21 October 1976 laid out plans for an organization to overcome the ADP problems identified in all three studies. Consequently, NAVDAC was born and in full operation by January 1977.[7/]

In May 1981, a Surveys and Investigations staff of the House Appropriations Committee (HAC) was charged with determining NAVDAC's effectiveness. HAC reported that NAVDAC was ineffective. HAC also attempted to tie this failure and the Navy's overall problems in ADP to the management provided by upper-echelon Navy commands. HAC gave the following reasons why:

- o NAVDAC is too low in the overall organization and thus lacks the visibility or support it needs.

- o NAVDAC has not set up standardized systems across command lines.

4/U.S. Navy, "ADP Reorganizing Study-Group Report, September 1966.

5/GAO, "Ways to Improve Management of ADP Resources in the Department of the Navy," 16 April 1975.

6/U.S. Navy, "Navy ADP and Information Systems," 29 June 1976.

7/NAVDAC is a shore activity under the direct command of the CNO. Its mission is to administer and coordinate the Navy nontactical automatic

- The Navy's ADP acquisition agent, the Automatic Data Processing Selection Office (ADPSO), a component of NAVDAC, is not functioning effectively.

- NARDACs, under the command of NAVDAC, have been overtaken by time and technology.

- NAVDAC does not have satisfactory control over the Navy's ADP resources.

The inadequacies of Navy management of ADP cited in all these reports were the initial points of departure for this study by BOTCAP.

The BOTCAP committee review reveals that the Navy has made a great deal of progress in ADP management since the latter was reorganized in 1977. And the Navy, like other large, complex organizations, must solve a number of very important problems to reach its goals and meet its objectives. To do so depends critically on the effective development and use of information systems. Solving the ADP problem alone, however, is not enough to improve the management of Navy information systems.

The great bulk of the briefings given to this committee emphasized hardware and software specifications. There were too many people who knew how the equipment worked and too few who could answer the question, Why do Navy managers need this information?

It appears that little has been done to answer this type of question. The new thrust we recommend would give much more attention to Navy managers' requirements for information along with the necessary development of personnel who can do this type of work. These comments are intended to emphasize the need for an information systems strategy that will help top management and those who design their information systems. Delegation of information systems analysis and design to

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7/data processing program. Key functions include providing staff support to the CNO in all ADP matters. This support in many instances is in furtherance of CNO staff support to the senior ADP Policy Official, ASN(FM), providing technical guidance and staff assistance in ADP matters to the Director, Command, Control and Information Systems Division (OP-942). (Ref. OPNAV Instr. 5450.2 of 27 Dec. 1978 -- NAVDAC; mission and functions of.)

Among its many other responsibilities, NAVDAC manages seven NARDACs. Each center is staffed with military and civilian personnel and contains large-scale data processing and data communication equipment. NARDAC provides computing and other services to the customers in its region and performs assigned lead functions for all Navy users. Another field activity of NAVDAC is the ADP Selection Office (ADPSO), the procurement arm of NAVDAC. (Note: A CNO letter of 2 February 1983 directed the transfer of this activity to CNM.)

technical specialists has left a large gap between the information that managers need and the information that they get. A high proportion of the Navy's problems with information are not those concerned with the usual technical components of information systems -- technology, hardware, software, systems design, data processing and processes, and data communications. These components are necessary but not sufficient for good management of Navy information systems.

The Navy has yet to face important issues related to information resources management. Information is the important resource. The problem is not just the management or the control of ADP systems; it is also to ensure that the Navy seizes the opportunity to improve the Navy's effectiveness, economy, and readiness by improving its ability to deal with information critical to its functions.

What is needed is a new thrust, and that new thrust must recognize the following principal characteristics:

1. The Navy must become knowledgeable in treating information as a scarce and valuable resource.

2. The Navy must organize a high-level mission that will be responsible for information resource management across and down through the Navy.

3. The Navy must change its orientation from efficiency of operations to effectiveness of operations. This means that the new thrust with all information systems must originate with and be driven by Navy missions and the information requirements of these missions.

Each of these parts of a new thrust will be put to the test in the near future. Today, the Navy is being called on to undertake ever-increasing national security tasks in areas of the Middle East, the Indian Ocean, the Caribbean, and South America. As naval forces form the backbone of the U.S. response in these areas, they must be prepared to meet threats that are becoming more and more technically sophisticated with advanced military equipment. The resources, however, with which the Navy must act, though increasing somewhat in quantity (toward a six hundred ship Navy) and sophistication (as naval weapons systems are upgraded or replaced), are expected to be in too short a supply to meet all threats. Needless to say, naval forces will have to be developed and operated effectively, to carry out missions in peace and war.

During tensions or conflict the Navy must put manpower to good use. In peacetime a critical problem involves reducing the cost of force development and operation. The Navy recognizes only too well that information is the key to effective force utilization in peacetime and in war. To provide the information needed for effective weapons employment and decisions that are tactical and urgent, the Navy devotes large resources to information and control systems. Perhaps less well recognized is that the distinction between tactical and nontactical

information is not always clear because many tactical decisions depend on information that is normally designated as nontactical, for example, information about the availability of resources. Certainly, the great role that information can play in effective force development and efficient peacetime operations is not well understood and appreciated in the Navy.

The effective use of information holds the promise of improving decisionmaking at nearly every organizational level within the Navy. With the limited dollars that will be available to develop the most effective naval forces, improved decisions will be needed to reduce noncombatant manpower requirements to support those in combat and reduce costs of force development and peacetime operation.

It is in this context that the new thrust for Navy information systems should receive its high priority. Achieving these projected improvements requires a clear understanding of the information that is necessary to undertake missions, make decisions, and take actions. Clear understanding of information systems and their proper use can facilitate the development and use of the needed information. Such a system, however, will be of little use without a well-managed organization for Navy information systems and a well-established planning and implementing process for actually putting the information plans to use.

In the next three chapters of this report, the committee spells out its findings on how the Navy is currently conducting its information activities and recommends ways the Navy can achieve this new thrust for more effective information systems.

II. IMPROVEMENTS NEEDED IN THE NAVY'S INFORMATION SYSTEMS TECHNOLOGY

The computing equipment the Navy uses covers a wide range -- from the newest generation of personal-size microcomputers to the early vintage, batch-processing computers whose counterparts in the private sector have long since been retired. A growing number of automated systems enable the user to access multiple computers from the user's own terminal. These on-line, terminal-based systems reduce delays and give more responsive service, yet most of the Navy's ADP equipment is still operated in the batch mode, using software that consumes considerable time and energy.

Data processing has improved personnel efficiency, reduced clerical labor, and provided managers with accurate reports on the status of activities. Nevertheless, the computers, computing installations, and software activities are expensive and are also largely the domain of specialists. The Navy has been compelled to devote too much attention to managing the data processing so as to avoid criticism leveled by congressional committees and oversight agencies.

New technology challenges the assumptions that have made computing an object of management control. No longer is it necessary to regard computer systems as the exclusive province of specialists. The microelectronic revolution has decreased the cost and increased a thousandfold the performance of computing equipment and now makes possible new applications for digital equipment. Today computers can be used economically in offices, small ships, or on desks. Even the smallest personal computers or word processors can have easy access to information stored in other systems. The new technology differs from the old in many important respects. And the Navy must adapt to the opportunities this new technology affords.

Findings

The Navy has accumulated billions of dollars worth of nontactical information-processing equipment over the past three decades. This investment in hardware is matched by an even greater investment in software. Both hardware and software also represent major costs for maintenance and operation.

Some equipment, for example, AN/UYK-5, AN/UYK-7, carries military designations, although most equipment ashore is of an ordinary, commercial grade. Word processing systems and personal computers proliferate ashore and afloat, because their low cost and ease of acquisition make them desirable in addressing small, localized information needs.

The capabilities of data communication are similarly varied. Some large, fixed systems exchange data by way of leased telephone circuits. Some command headquarters are exploring certain experimental and

prototype local area networks with wideband capabilities that can interconnect office automation equipment. Also, the Navy is preparing to use the new Defense Data Network (DDN) that has replaced Autodin II as a military packet-switching equivalent to the Arpanet. But as it stands, communication of nontactical data to and from ships remains slow and limited in flexibility.

As the Navy moves toward the use of more modern and effective information systems, it must solve the difficulty of integrating these components. Inefficient, obsolete hardware and software should be replaced by systems that can communicate in standard protocols and interconnect with word processors and office automation systems. Users should be offered modern software capabilities, such as database management, high-level query and extraction, and presentation graphics. Systems now under consideration should be reviewed to make sure that they can add these capabilities in the future.

Across the Navy, five interlocking components important to modern information systems have until now been allowed to develop separately. These five are conventional ADP equipment, personal, or desk-top, computer systems, word processing systems for office use, data communication capabilities and networks, and -- overriding and controlling all -- software. Because these components need to be integrated, the Navy needs organizational and policy solutions to preclude their separate development.

Software. To date, commands with information-processing requirements have generally developed their own software. This is true except where a nearby NARDAC has programmed a system for commands without software staffs. A program to be installed and operated at more than one location or used by more than one user organization can be maintained and supported centrally by its designers. Such a central design activity (CDA) avoids multiple and wasteful versions of the same software being maintained and supported by several programming groups. A CDA, being maintained and supported by one programming group, fosters uniformity, minimizes maintenance costs, and makes improvements and new features available simultaneously to each user.

CDAs within the NARDAC structure play an important technical role for the user organizations that are too small or ill-prepared to maintain programming staffs. The NARDACs, as field activities of NAVDAC, can provide trained, experienced systems designers to develop software, following Navy software standardization guidelines and documentation procedures. When operational, the software can be installed and run at any of the NARDACs and be available ashore at many locations uniformly. Without NARDACs, the only alternative for small users would be to implement software, or software and hardware combinations, independently. This would result in a small chance for standardized procedures, the hardware and software would not be compatible with other Navy systems, and the user would be forced into the role of maintainer.

As the Navy begins to integrate systems that are now separate, a new

kind of CDA will be required in the future. Creating these "systems of systems" requires the expertise of many specialists in data networking, communication software, and interchange protocols. Because these specialists must be available across organizations and commands, the proper place for them would be in a technologically current, well-respected specialist command. A strong technical advisory and consulting organization such as this is particularly important to support the decentralized development of applications using small, personal computers.

The term systems of systems illustrates the concept of connectivity: System A could be the collection of computers, files, terminals, and the staff responsible for personnel recordkeeping. System B could be the office automation system at a command headquarters. System C could be the computers of the pay organization. Users would be interconnected by a local network that could access external networks.

In the development of modernized Navy information systems, interconnectivity is paramount when information requirements and architecture determine that data must flow between them. This interconnectivity can be achieved, for example, by having the appropriate systems participate in the Defense Data Network (DDN) or by directly connecting a node of System A to nodes of Systems B and C. The Navy should not design systems, assuming that their data will never have any value outside the systems or assuming that information from the outside the systems will never be required within the systems. The exception, of course, being systems that handle classified information.

Office support systems are an example of the need for a CDA. Many Navy organizations have begun to experiment with minicomputers and microcomputers for office automation. This has attracted many vendors, each offering to combine word processing, electronic mail and filing, and local data processing into a system of sometimes bewildering variety. For, like the personal computer, different and incompatible approaches to office automation run the risk of uncontrolled proliferation and a lack of interoperability.

As an example using a full-function office automation system, a budget proposal or a personnel inventory file is developed and stored on a mainframe computer system. The senior manager can call the copy of the working file for display on a terminal via a data communication network. Using an electronic mail system located at Headquarters, the manager can then circulate the reviewed file to members of a command staff for comment. The modified version is then incorporated into a draft memorandum being prepared on a word processing system. It doesn't have to be retyped. Before being finalized, the draft is forwarded for review to other offices in the same building or even across the country.

Office and command management staffs need access to a Navy source of computer-application expertise and guidance to help avoid costly mistakes and to ensure compatibility of office automation systems across the

Navy. The field operations of NAVDAC are in an excellent position to assume the role of advisor and innovator.

By providing the terminals, word processing, and foundations of electronic message communication, office automation can put the Navy's managers and support staffs in command of the information they need to function effectively, whether it comes from the office next door or from an office across the country. Unfortunately, office automation systems that developed without regard for interoperability would remain isolated from their counterpart systems in other commands. Furthermore, they may not be able to participate in a communication network that could link them with larger systems.

To respond to the demands of uniformity, the Navy might consider office automation systems as candidates for CDA development. One or more NARDACs could develop demonstration projects that would show ways to automate the administrative work of several headquarters offices or operations centers of different sizes. Specific attention could be placed on connectivity between the centers, interoperability with mainframe computer systems, and use of both local- and long-distance data networks.

Obsolescence and replacement. Computing equipment is subject to rapid technological obsolescence. A new generation of equipment appears roughly every seven years; however, commercial users of data processing equipment generally follow replacement policies that rarely keep them more than a generation behind the state of the art. The reasons why this is so are economic: With each new generation, the capacity and performance per dollar expended for equipment, operation, and maintenance increases sharply. In spite of this, the Navy, like other government agencies, operates nontactical ADP equipment far beyond its useful life, as defined in the private sector. Today, too many Navy installations still operate punched-card accounting machinery, and too much of the Navy's ADP equipment inventory was produced in the 1960s. Such obsolete equipment is rarely found today in commercial or academic installations.

The problems of operating obsolete ADP systems are many. Whereas older systems cost much more to operate and maintain, newer systems usually pay for themselves within two years through savings in maintenance, energy consumption, floor space, and time lost because of unreliability.

Older computer systems have technological limitations that impede the development of new applications. Because the high cost of main memory in older systems makes it impractical to run interactive, terminal-based applications on them, they are forced to run in the old and inefficient batch-processing mode.

Furthermore, it is becoming increasingly hard to find and retain qualified personnel who are able and willing to work on the old equipment and its operating software. After all, what motivation is there for

anyone to become proficient in using, programming, or maintaining systems that are no longer in use outside the Navy?

Software, as well as hardware, becomes obsolete, so modernization efforts should pay equal attention to replacing them both. Modernizing software involves redesigning it to exploit the new equipment's capabilities such as better communication and file systems. Merely rehosting the old software on new equipment does not fully address the obsolescence problem.

Because the government insists on fully competitive procurements, however, the Navy cannot always modernize older equipment with newer equipment from the same vendor, assuming the vendor is still in business. Contracts should, if possible, incorporate technological upgrade provisions that use compatible software for future improvements.

NAVDAC has had success negotiating a contract with the flexibility to upgrade mainframe and peripheral equipment in the NARDAC centers. This effort will have paid for itself when the equipment has to be modernized, thus giving NARDACs a fully competitive computing service with NIF funding.

Locations and physical plant. Computer installations exist everywhere in the Navy. On the larger ships, nontactical ADP equipment operates around the clock, sometimes in a constricted space, to perform the variety of administrative and support tasks of the ship. Some ships have experimented with word processing equipment, and some personal computers supplement the shipboard computer or, on small ships, provide the only onboard data automation.

The Navy must anticipate the problems of maintaining commercial-grade personal computers or word processors for an extended time. Use of these systems afloat may be made attractive if provided with training for technicians, sufficient backup systems, and supplies to maintain them. The data processing installations ashore vary widely in physical facilities. In general, budgets for military construction are so competitive that allocations for nontactical computing facilities are less than generous. But NARDACs are an exception: Over a period of years, their facilities have been improved. Although much work remains to bring them up to modern standards, the NARDAC facilities for equipment, personnel, and uninterruptible power supply verify the benefits of belonging to a command whose mission is data automation.

Data communications. As systems become interconnected and more on-line information services are implemented, data communication problems grow. At present, communications to host computers use conventional, leased, voice-grade telephone circuits. Radio circuits that carry message traffic handle communications to and from computers afloat. The bandwidth and characteristics of the channels for this traffic do not support more sophisticated kinds of interactive traffic to other installations ashore or afloat. Tactical satellite links are, of course,

available, but there is understandable reluctance to load them with nontactical traffic. As new communication capabilities are made available to ships, the need for both tactical and nontactical data handling should be represented when information requirements are being determined.

The nontactical ADP community ashore must attend to the rapid development of local networks for geographically compact areas, such as headquarters buildings or stations and also the establishment of the Defense Data Network for long-haul interconnections of host computers, work stations, and terminals. The existence of the networks presupposes the overall development of a flexible, simple, high-performance data exchange among dissimilar hosts and terminals. To date, the experimental work done by Navy laboratories and the experience gained through Navy representation in the definition work on the DDN have been sufficient to gain familiarity with networking. The next step, however, will be to apply this technology to a growing number of new information systems applications. Substantive leadership by an expanded NAVDAC would have many opportunities to design demonstration projects and construct prototypes of local office networks that interconnect remote areas.

The present charter of Naval Telecommunications Command (NAVTELCOM) to provide communication capabilities defines sharp boundaries between the data community and the communication community, usually at an interface point such as the modem equipment. With such arbitrary definitions, not all data communication networks can be well designed and operated. This is especially true in the case some of the more modern digital links in which there are either no conventional telephone circuits or in which satellite links provide raw digital bandwidth.

There are no obvious ways to integrate the work of one command (whose data processing charter requires increasing communication involvement) with another command (whose communication charter requires a greater knowledge of digital computers and network techniques). NAVDAC and NAVTELCOM, therefore, must continue to develop and sustain a close working relationship. This way each has the chance to understand the other's activities and can contribute to projects requiring joint participation.

Recommendations

Although the committee considers its charter to include only nontactical ADP, it urges the Navy to pay close attention in the future to the interrelationships between support systems like ADP and the accomplishment of the tactical missions they support.

The committee recommends that in developing the new Navy information systems, the Navy should

1. Accelerate the retirement of obsolescent computer equipment and software. Systems using outdated hardware and software cannot

easily participate in the more effective distributed networks of the future.

2. Pay special attention to data communication compatibility in acquiring new equipment. Computers acquired without communication capability are likely to become obsolete much more quickly than those that have the capability to become part of the interconnected systems of the future.

3. Remove all barriers to the full interconnection of word processing systems, office automation systems, and personal-size computers. These specialized computing systems can be important elements in the integrated systems that will emerge.

4. Strengthen the working relationships between NAVTELCOM and NAVDAC to facilitate the vital interconnection of the components of the new systems. Local area networks at command headquarters, wide-area networks such as the Defense Data Network, and specialized networks optimized for data transmission must all be engineered in close teamwork with the computer systems they support. Computer people need data communications expertise just as much as today's data communication people need computer expertise.

5. Augment substantially the availability of technical expertise in small-scale, distributed computing. The benefits of an end-user computer can be most impressive in terms of local information needs; nevertheless, there are many pitfalls and few sources of accurate advice. Although small-scale systems are usually procured to address a local, near-term need, their users will, in the long run, benefit by taking standardized approaches. That is, Navy-wide guidance and technical assistance is necessary to ensure compatibility across command lines. Fortunately, the initiatives of NAVDAC, and its field structure already in place, form the basis for this activity and should be enlarged and given more widespread attention.

6. Assign a new CDA focus to NAVDAC to design, demonstrate, and implement new systems that cut across command lines. Examples of these would include office automation, electronic mail networks throughout the Navy, and networks of communicating personal computers. The need for interoperability in such cross-command systems is as great as it is for standard telephone systems or mail addressing. Interconnectivity is one of the keys to the Navy information systems of the future. It cannot be attained by separate, uncoordinated development.

Conclusion

Information technologies permeate virtually every Navy activity. The more the Navy recognizes the true value of information as a resource,

therefore, the better the Navy can improve its ability to communicate large amounts of information arising from many sources. The recent explosive advances in information technology have been accompanied by a decrease in equipment cost. With this in mind and under strong leadership, the Navy can greatly improve its efficiency, economy, and readiness. Yet to do so it must first cope with the problems that impede the effectiveness of its information processing.

The first problem the committee looked into was the way Navy plans for information systems are developed. In the next chapter, the committee reports on its findings and recommends how the Navy's information systems plans can be improved.

III. STRENGTHENING THE PLANNING OF NAVY INFORMATION SYSTEMS

Information systems[8/] generally fall into one of two categories: Systems that process transactions and provide detailed recordkeeping and systems that are designed to support decisionmaking.

Transaction processing systems. Planning for transaction processing systems is different from planning for decision support. Transaction systems resemble mass production operations and, therefore, are usually treated as a factor of productivity and cost control. Planning for transaction systems is partially a matter of anticipating the size, quantity, or speed of the data processing and supporting input-output facilities the Navy will need in the future. Because size, quantity, and speed depend largely upon available technology, the planning of transaction systems is and will be based primarily on the estimated cost of the hardware and software needed and the life-cycle support costs.

The major difficulty in planning for transaction systems is the lack of a good method for measuring projected workloads. At the upper-echelon level of the Navy, planning for the Navy's transaction systems workloads should involve more than the stapling together of "wish lists" received from lower levels. It is imperative that the Navy ask and strive to answer the questions, What are we counting? In what units do we express our workload estimates?

The methods currently available for estimating processing workloads to determine the hardware and software capacity are suspect and in need of change. Such change should be sponsored and planned at the CNO level. Equally as important as accurately estimating workloads is the development of the answers to the following two questions: Why are these transactions being processed? Are the costs justified?

Decision-support systems. Although both public and private organizations have had significant experience using computer systems to process their transactions, few have called on computers to support executives in decisionmaking. Organizations that recognize the importance of such applications, however, are beginning to invest in developing and testing decision-support information systems with the capabilities to

- Build an early warning management system that can clarify potential opportunities or give early warning of hazards.
- Better prepare the organization to order its decision priorities and choose the best options.

These capabilities are, in fact, the reasons why an organization makes plans. So an information system that supports decisionmaking

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8/The following discussions exclude intelligence and surveillance information systems on which, the committee understands, the Navy has concentrated planning and implementation resources.

naturally becomes an integral part of the organization's planning process. The converse is also true: The planning process also becomes part of the organization's information systems.

In certain cases, the logic behind a decision can be used further to spell out the information requirements -- what data are to be collected and processed to support informed decisions. The advantages of decision-support systems are especially important in organizations faced with sharply increasing workloads. Being in this very situation, the Navy should be interested in developing decision-support systems.

Findings

Navy information systems have for the most part been treated only as transaction-systems problems of hardware or software. With few exceptions (for example, OP-01, Manpower, Personnel, and Training), Navy information systems receive no planning attention because too many Navy commanders give such work low priority, viewing information systems as clerical-level recordkeeping. Although command should remain the number one priority, commanders cannot give the right orders without management and administrative expertise, a sufficient organization, or timely, appropriate and correct information.

It is not widely recognized at top echelons in the Navy how most missions are intrinsically tied to information. A consequence of this lack of top-level awareness, as well as confusion in the planning process, is that the wrong signals are given to middle management. Thus, resource sponsors[9/] tend to give weapon systems and platform programs the highest priority, while overlooking the critical contributions made by the ADP resource.

It is advisable for Navy information systems planning groups to have mission operational experience in order to recognize valid requirements, potential opportunities to apply technology and provide feedback to lower-echelon units on ways to improve their planning. Planning groups also need technical knowledge in order to understand issues created by the rapid changes in technology.

The sole purpose of information systems is to support the missions of the Navy. They need to be planned as such. Missions alone justify expenditures, including expenditures for information, so the selection and the statement of information requirements must originate from within the part of the organization that is responsible for mission results. (Information requirements may also include those posed by higher or external authorities.)

9/A Deputy Chief of Naval Operations (DCNO) or Director, Major Staff Officer (DMSO) responsible for programming resources within an identifiable aggregation. (Navy Programming Manual, 20-NB)

In fact, personnel at the CNO level can be involved in information systems planning only if they are high enough in the organization, the CNO and the VCNO expect them to participate, and they demonstrate how they can help those with missions.

The discipline of participating in the planning process is more important than getting the hard copy of the plan. Decision-support systems that facilitate such participation deserve special attention.

Current Navy planning. Planning for Navy information systems can be better understood only in the context of the yearly budgeting and appropriations that take place within the federal government. The various goals and objectives for Navy missions, as developed within the OPNAV, are the starting point for the Planning, Programming, and Budgeting System or PPBS.

As guidance is being sent down through the organization, lower levels submit plans for higher-level approval. There can be several iterations with higher levels alternating between giving broad guidance and approving or rejecting lower-level plans.

In theory, the PPBS process is conducted by a claimant,[10] a functional sponsor,[11] and a resource sponsor. Claimants come from the various units that need some sort of ADP system. They make requests through the chain of command for resources, usually in the form of an ADP program plan, to a resource sponsor. The resource sponsor interprets mission goals and objectives, establishes priorities for resource allocations to programs, and presents and defends resource requests through the PPBS process. Resource Sponsors can also generate resource requirements.

Functional sponsors are higher-echelon units, responsible for providing ADP planning guidance, and coordinating ADP activities in a functional area. Functional sponsors may or may not also be the resource sponsor for a mission. They are unique to ADP and are not used in other activities.

When, or sometimes before, funding for an ADP program has been allocated as part of the PPBS process, it goes through an ADP Approval Authority[12] command chain, often another set of players entirely, that

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[10]One of fourteen headquarters components which receive operating budgets from OPNAV. (NAVCOMPT Manual 071122)

[11]A DCNO/DMSO-level official responsible for functional information systems planning within a specified purview. (SECNAVINSTs 5240.1A and 5230.9)

[12]An official authorized to approve certain ADP actions within established thresholds. (SECNAVINST 5230.6B)

control step-by-step acquisition. Consequently, there are two separate planning chains somewhat displaced in time that handle ADP programs: One deals with requirements and funding, the other with approval and acquisition. It is the interplay between these two chains-of-command that often determines the eventual success or failure of a program.

As exercised by the Manpower, Personnel, and Training organization, the current planning process works smoothly when the resource and functional sponsors are part of the same organizational unit, the linkages to the ADP Approval Authority are explicit, the resource sponsor recognizes the importance of information systems, and a high-level group staffed with senior, qualified information systems personnel has been established. The process breaks down, however, when responsibilities are not well defined or the boundary of the ADP system extends beyond the activities directly controlled by a resource sponsor. In systems that will cut across the boundaries of several functional areas, problems develop with coordination and integration.

Following are examples of current planning in the Navy:

Case 1 -- OP-01, Manpower, Personnel, and Training (MPT): Planning When the Functional and Resource Sponsor is the Same Person -- This case is an example of the way planning occurs at a major functional level and is coordinated with the Program Objectives Memorandum (POM) process to come up with its resource allocation.

The process begins when both the Department of the Navy (DON) and the CNO issue broad Navy-wide mission goals and objectives. From analysis of the DON's goals and objectives come the programs and projects, which are subsequently reflected in the POM. This is interpreted with OP-01 specifying the direction for MPT to take. Some of these objectives are stated in terms of what the missions rather than the information systems are expected to accomplish, such as, setting and achieving manpower levels, developing and providing training programs, determining critical skills to be provided, and so on.

The strategic planning process at OP-01 is relatively informal; that is, business strategies are not explicitly stated in a formal "business plan." The individual exercising the functional sponsor's responsibilities for MPT, however, is intimately involved in the business-planning process and is sufficiently familiar with the goals and objectives of OP-01. The functional sponsor reviews the project plans of Manpower, Personnel, and Training Information Systems (MAPTIS) claimants and produces an information systems strategy that sets the objectives and goals for MPT's information systems and is consistent with the mission objectives of OP-01.

At present, the functional sponsor does not receive information systems strategy and objectives from the corporate Department of Navy Automatic Data Processing Manager (DON/ADPM) level. This level will do so in the future. This strategic plan enables MPT to integrate the

corporate information systems strategy and objectives into its own more specific major functional strategies and objectives.

From the overall strategy, the functional sponsor produces program proposals that define in detail all automated information systems (AIS) currently in process, as well as new initiatives and resource requirements associated with each system. The POM is submitted for approval, and contends with the POMs submitted by all other functional units in MPT. The resource sponsor has to defend the information systems initiatives in the POM process.

The resource sponsor then uses the approved POM submission in the budget process. Although there is no separate budget for ADP, the ADP programs and resources are reflected in a special budget exhibit. The resource sponsor negotiates for his respective claimants, and at MPT, the functional sponsor and the resource sponsor for information systems are the same individual. This facilitates negotiations. In MPT, the roles and functions of the functional sponsor, resource sponsor, and claimant have been defined in such a way that the process works effectively.

OP-01 prepares and sends to DON/ADPM an extract of the POM that details information systems projects for MAPTIS, as well as the resources required. DON/ADPM incorporates this extract into the Navy Information Systems Plan (ISP). The Assistant Secretary of the Navy for Financial Management [ASN(FM)] issues the ISP, a compendium of information systems plans for each major area of the Navy.

The following characteristics of the OP-01 organization and sponsorship contribute to its advanced planning status.

1. The resource sponsor and the functional sponsor are the same individual. Further, the claimant function is performed in part within the OP-01 staff and in close coordination with the MPT major claimants.

2. OP-01 recognizes that properly defined information requirements are fundamental to mission success. AIS requirements for the function are formally stated and used to drive the planning process for such information systems.

3. The AIS planning requirements cover claimants with a direct command or resource relationship with the sponsor.

4. OP-01 has a technical and operational staff. Leadership within OP-01 actively supports the development of appropriate AIS planning.

5. Given its technical and mission operation experience, OP-01 staff recognize that benefits derived from defining valid information requirements include a reasonable potential for implementing them as well as obtaining the appropriate technology available.

The planning process for MPT is working well, with certain problems to be resolved. MPT planning procedures are well founded and oriented toward planning information systems through early definition of information requirements.

Case 2 -- Office of the Deputy Chief of Naval Operations, Logistics (OP-04) Planning When the Functional and Resource Sponsor are Different People -- The MPT characteristics are not found in the other major functional units. An example is that of OP-04 and NAVMAT.

Following is a point-by-point comparison of OP-04 with OP-01:

1. In OP-04, the functional sponsor and resource sponsor are the same office. No claimant function is performed; NAVMAT is a major claimant for OP-04.

2. Although major nontactical ADP (NTADP) requirements may exist, they are not necessarily information oriented. Within the overall planning of OP-04, information systems are not treated as a highly visible item.

3. The NTADP requirements covered in the sponsor's planning are not based on a strong, clearly defined relationship between the command components, systems commands, and the office of the major claimant to whom they report.

4. The functional sponsor apparently has no concentrated, technically experienced staff to lead the planning of requirements, benefits, implementation plans, or technology appraisal. Because there are few resources in this area at OP-04 or NAVMAT, the review process, if any, tends to be passed down the organization to lower levels.

Within this framework, in practice the major claimant -- or more correctly, the claimant's system commands (SYSCOMS) -- handle all the planning input. The resource sponsor may debate rates or some other aspect of funding, but otherwise accepts the plan that the major claimant assembles from a collection of essentially unreviewed, independent plans within the POM process.

The functional sponsor works these plans into a package and forwards them as the major content of the Information Systems Plan (ISP) submission. It is then up to the resource sponsor to defend the resource requirements of the ISP in the POM process. But because the resource sponsor is not actively involved in developing the ISP, and because the links to mission accomplishment may be unclear, the sponsor is not in a position to use the ISP input effectively in POM negotiations.

The comprehensiveness and degree of coordination and appraisal varies within individual SYSCOMS plans. At Naval Facilities Engineering Command (NAVFACENGCOM), for example, plans are very complete. Within NAVFACENGCOM headquarters lies a knowledgeable and interested leadership and an organization with field management and AIS experience. Their

planning, which is integrated and action oriented, is done not only to meet the letter of the planning requirements, but also in response to requirements from subclaimants who have legitimate operational, management, and control needs.

Naval Sea Systems Command (NAVSEA) and Naval Supply Systems Command (NAVSUP) are less complete in their total planning efforts. Their internal organizations, as applied to the AIS planning functions, necessarily vary, primarily because of mission differences. By comparison, other component commands within NAVMAT have relatively primitive planning activities.

Because the SYSCOMS are also command components (as identified in SECNAV INSTR 5230.9), each submits an Information Systems Support Plan (ISSP) to the CNM, the office of the major claimant; CNM simply assembles the ISSPs and passes them on to Office of the Director, Command and Control Support Systems and Information Systems Division (OP-942). In turn, OP-942 distributes appropriate portions to functional sponsors and consolidates their responses in the annual ISP.

OP-01 knows that there is an indispensable step between PPBS and the approval of the acquisition of ADP hardware and software. By carefully analyzing the changing missions and functions of their organization, MPT systems personnel produce thorough descriptions of the types of information that should be obtained by data processing. This step of translation between PPBS and ADP approval is a critical one, although it is not at present a normal process in the Navy.

For most Navy personnel, the words systems requirements refer to needs for the technical specifications of computer hardware and software. Rarely is there any reference to the types of information needed, who needs this information, or why. In economic terms, little attention is being given to either the demand for or the value of information. As such, most of the attention and budget focus is on supply or processing of data.

The present emphasis by Office of Management and Budgeting (OMB) and ASN(FM), for example, on controlling hardware supply and processing data creates an enormous bias against any kind of planning of Navy information systems. This one-sided, cost-only ritual is tantamount to running a large organization with a single-entry bookkeeping system, that is, all costs and no benefits, services, or revenue.

Recommendations

Recommendations for improving the Navy's information systems planning are listed below. They are the basis for the committee's recommendations on organization and management in the next chapter.

1. Acquisition strategies should be considered at the time a system is conceived and the requirements are established, rather than at

some later time, after the program has been approved. The whole acquisition cycle needs shortening.

2. The PPBS should be considered as a process to achieve organization objectives rather than an objective in itself. On an ongoing basis, PPBS must be coupled with other planning activities, such as assessment, architecture, and requirements analysis.

3. The office of the CNO should take the leadership and direct that there be substantial improvements in the development of requirements for its information systems on the basis that the projected values from the information systems justify the projected costs. The CNO may want to include these arguments when requesting approvals from higher and external oversight authorities.

4. Information systems should be mission driven. The information systems staff in the office of the CNO should be directed to lead such a changeover. The very involvement of matching missions with needed information is another way of planning Navy information systems. The work done in MPT, where information requirements are part of the planning process, is an excellent example of the system of planning that other subcommands should follow.

5. In order to better inform mission commanders, the mission planners and information requirement planners need to strengthen planning by working together. As a byproduct of this, much clearer statements of information requirements become available to those who must evaluate, design, and run the system.

Mission planning and information planning being, in fact, two sides of the same coin, must be treated together. Indeed, the information requirements for mission planning are the same requirements for information systems planning. Perhaps most important, because of the automatic built-in coordination between missions and information systems, an information architecture can support understanding and judgment.

These findings and recommendations on how the Navy can improve its planning to use more effectively both its current information technology and the emerging advanced information technologies are the basis for the committee's findings and recommendations on the Navy's organization and management of its information systems in the next chapter.

IV. IMPROVING THE MANAGEMENT AND ORGANIZATION OF NAVY INFORMATION RESOURCES

In both a briefing to the VCNO in December 1982 and an interim report to the Navy in July 1983, the committee provided the results of its first six months of study on the problems in the Navy management and organization of its information resources.[13/] The committee's additional review and study since the July 1983 report has substantiated the preliminary findings and recommendations of the interim report. This chapter is an elaboration of these findings and conclusions.

Since 1966, studies have consistently shown that the management and organization of Navy ADP is unstructured and decentralized. Top Navy personnel have been criticized for giving low priority to the organization of information activities. To reap the full benefit of the new information systems, therefore, the Navy must substantially modify the direction of the management and organization of information systems.

Findings

No effective focal point exists, particularly at the CNO level, to direct the planning and coordination of the information needs of the functional sponsors and the components of the Navy. Because there is a lack of a strong upper-echelon information systems office within OPNAV, the Navy has not adequately developed top-down requirements documents. What's more, most functional sponsors lack the staff and expertise to generate such a document.

NAVDAC does a significant amount of OPNAV-related policy work for OP-942 and performs other work for the rest of the organization. Indeed, the policy directives, technical standards, and advisory guidance that NAVDAC has promulgated have improved the uniformity of ADP hardware, software, and practices.

The NARDACs perform valuable computer services for a wide spectrum of customers. These centers, under NAVDAC, have responded effectively to increases in workload and have improved the quality of services delivered. Although facilities have improved since coming under control of NAVDAC in 1977, significant improvements are still required and will take time. The interdependence of NARDACs and NAVDAC as a specialized organization is vital to creating and retaining a critical mass of information systems capabilities.

Significant elements of information systems reside in the Office of Assistant Vice Chief of Naval Operations/Director of Naval Administration (OP-09B), the division responsible for Navy word processing programs and

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13/ Navy Nontactical Automatic Data Processing Policy, Organization and Management (Interim Report to the U.S. Navy), National Academy Press, Washington, D.C., July 1983.

equipment management. But information management activities under OP-09B are too closely related to the Navy information systems effort to be managed independently of the mainstream effort and should therefore be transferred into a centralized information systems division under OP-094.

Within the office of the CNM, information functions are assigned to the Director of Information Systems and Administration (MAT-09B). This office does not represent a strong upper-echelon office for information systems. By consolidating the information systems (AIS Policy, Office Automation, ADP Support Center, and SNAP Program Office) and delegating greater approval authority to the SYSCOMS, CNM has made favorable changes in MAT-09B. The effectiveness and authority of the office is greatly reduced, however, by adding to it such unallied functions as administrative support, space management, and physical security. The CNM lacks a strong upper-echelon office of information systems. Because of this, the needed emphasis on increased coordination across NAVMAT to implement CNO-level guidance and directives in information systems can not be attained.

Even though OP-942 is supported by NAVDAC, it has relatively few resources. In the past, OP-942 has concentrated on reacting to problems, for example, performing compliance monitoring at a relatively low level, rather than defining the overall scheme for Navy information systems, assessing programs and plans, assigning responsibilities for programs, and setting priorities, or identifying opportunities to apply new technology and sponsor seed programs. In other words, OP-942 has been acting in the role of controller rather than facilitator.

Recommendations

1. Establish one high-level advocate with explicit responsibility for the NIS. Under the direction of OP-094,[14]/the program sponsor, and the principal advisor to the CNO, this NIS officer (OP-945, for example) should be made flag rank and given the information systems responsibilities and military and civilian billets of OP-942[15]/ and

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[14]/Through control and coordination of Navy information systems, OP-094 generates the development of an integrated system that will meet the requirements of all levels of management in the Navy and acts as the central point of contact with OPNAV for automatic data processing matters. (Ref. OPNAV 5430, 4/8/82, Missions and Functions of OP-094, function number 25.)

[15]/The charter of OP-942 includes two significant points: (1) to act as the single Navy point-of-contact for the support of the senior ADP policy official ASN(FM) and (2) to exercise management control of all tactical and nontactical automatic data processing matters (less DOD Intelligence Information Systems) for the Navy. OP-942 is assigned, among other functions, the additional duty as the Director of Navy ADP Management (DON/ADPM) reporting directly to the senior ADP official ASN(FM). OP-942 is also charged with advising OP-094 on command-related matters affecting NAVDAC and serves as its program coordinator. (Ref. charter of OP-942.)

OP-09B.[16] This officer should also be the director (DON/ADPM) reporting directly to the ASN(FM). He should have no other responsibilities and should have a Senior Executive Service (SES) deputy or technical director.

Creating this office would significantly improve coordination across the Navy and increase assistance to functional sponsors.

Nontactical information systems functions from OP-942 and some functions from OP-09B would form the initial tasks of the new OP-945. Given its number of positions, OP-945 certainly cannot handle directly any depth in activities. So NAVDAC, and its NARDAC centers must continue to play a large role in the objectives and functions of OP-945.

A comparison of the current functions of NAVDAC and a list of the functions proposed by the Navy staff for OP-945 shows much overlap, and it should. In fact, except for major political reasons, it would be appropriate to team up these two functions. At a minimum, OP-945 can be NAVDAC's office at CNO, and NAVDAC (with its NARDACs) can be OP-945's staff and operational arm for the rest of the Navy.

We highly recommend this arrangement be continued. It is the only way that OP-945 can be successful. Any efforts to weaken NAVDAC and the NARDACs would severely limit the effectiveness of OP-945. Because ADP technology is dynamic, the OP-945 and NAVDAC team must have the competence and power to guide today's ADP production and tomorrow's information systems technology.

2. Strengthen NAVDAC's role as a Navy-wide center of technical expertise and support for field activities by adding technical staff and inaugurating demonstration and prototype facilities.

NAVDAC should report through the new consolidated division under the CNO but remain as currently constituted with the mission and functions as set forth in OPNAV Instr. 5450.2 dated 27 December 1978 and later expanded.

The scope and coverage of the Navy information systems mission assigned to NAVDAC should also involve the integration of conventional ADP with the recently adopted small computers.

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[16]/Under the VCNO, OP-09B develops, promulgates, coordinates, and administers the Navy word processing programs and provides general policy guidance and central inventory management of word processing equipment. (Ref. OPNAV Instr. 5430.48A dated 16 June 1982 - Charter and Functions of OP-09B.)

3. Retain the current structure of the NARDACS, reporting to COMNAVDAC. Modifications at this time are not recommended. With the institution of the Naval industrial funding (NIF) in October 1983, pressures to make changes can be expected from some of the Navy users. The Navy is cautioned to maintain a close watch on the situation and be alert to and oppose recommendations that would reduce the effectiveness of the NARDACs and their interdependency with NAVDAC.

4. Make an office within NAVMAT that is a central point of direction and coordination for all NAVMAT-related NIS functions. This new level of management would be higher than the current one. The office would take over all information systems functions now carried out by MAT-09B and would have duties related only to the information systems functions.[17/] This office should report directly to the CNM. It should also be designated the single point of contact within NAVMAT for information systems programs. The billets assigned MAT-09B for information systems would be transferred to this office.

Under the authority of the Chief of Naval Material, this office could provide systems integration, guidance, and direction as well as budget formulation and execution to the appropriate naval systems commands and CDAs. The office would also appraise the status and progress of work in order to ensure a fully integrated, coordinated, and timely information systems effort with the degree of standardization needed in the NAVMAT.

These recommendations would

- Elevate the management of NIS within OPNAV to a division director to be filled by a Flag officer. Within OPNAV, the sole responsibility of this officer would be information systems, unencumbered by major command and control programs. He would report directly to a DMSO and directly to the ASN(FM).

- Bring together related areas of information systems and give them higher priority attention by consolidating the Navy information systems under a single director.

- Provide a central point of ADP responsibility in OPNAV at the DCNO/DMSO level to assure a designated, visible focal point within OPNAV for DON coordination.

- Not disturb the current effectiveness of functional sponsors and provide for their intercommunication with other information systems.

17/MAT-09B provides ADP and information systems policy, resources approvals and recommendations, budgetary assistance for the Naval Material Command (NMC), and office automation and word processing services for Headquarters, Naval Material Command (HQNAVMAT). It also manages fleet nontactical information systems and related ADP applications, software, and equipment. [Ref. CNM (MAT-09B) Charter Document 123.]

- o Provide for the much-needed upper-echelon presence of a strong central information systems officer within the office of CNM to coordinate and implement programs of CNM information systems.

- o Provide for program integration, budget formulation, and coordination effort to support the SYSCOMS. Such an office within the CNM would give one officer sole responsibility for the Navy information systems instead of several officers as now assigned under MAT-09B. This should be flag officer billet reporting directly to the CNM. This would significantly improve the status of information systems within NAVMAT. The officer would also provide a focal point for the CNM responsibilities across the SYSCOMs, without disturbing the direct tie of the SYSCOMs with their activities. Likewise, the CNM changes would also provide a focal point for CNO to tie into CNM.

- o Make the existing participation in information systems by every level of Navy management more visible. To this end, a program organized to make missions and position responsibilities the main focus for the Navy Management (Information) Requirement Review should involve high-level policy and mission study personnel. This would show congress committees and oversight agencies that the Navy is giving more attention and resources to Navy information systems. In fact, these actions can also validate expenditures for information-related activities.

Beyond technology, OP-945 should demonstrate that a Navy information system is a major concern of top-level Navy management. With a gradual shift of labels from ADP to Navy information systems, present ADP functions would remain but would be upgraded. Overcoming stigmas associated with ADP by changing to a demonstrated focus to Navy information systems can be compared to the difference between the image of clerical support and that of Command and Control.

By shifting attention and resources to the hierarchy of decisions that all levels of Navy management must make, managers would give more attention to the value of information to carry out their specific responsibilities. Systems designers and data processors would benefit too because they could get improved statements of information that managers need. By emphasizing that only 4 percent of the costs of information systems are hardware costs, according to one IBM study, a strategy could be built around the other 96 percent -- primarily personnel costs of management, operations, and administration.

The Navy must reinforce the effort around the Navy Nontactical Automated Information Systems Standardization Program. What to standardize and how to standardize must follow the desire to standardize. Change can take place only gradually, after careful study.

With more attention to developing Navy information systems objectives, the success of well-coordinated Navy information systems

functions depends on clear objectives. The OP-945 and NAVDAC team should

1. Improve the image of all activities associated with Navy information systems. A high-level, single-point advocate for information systems implies clout and professional respect.

2. Reduce impediments to information systems improvements through political persuasion and adjustment, as well as by making the best case for the Navy. This could be done by representation in committees, boards, and the like; external relations with Congress, Office of Management and Budgeting (OMB), General Services Administration (GSA), National Bureau of Standards (NBS), General Accounting Office (GAO), and other agencies; coordination in all directions; and arbitration of disputes between claimants and sponsors.

3. Improve information systems content of mission and function analyses in all Navy offices and seek better ways to translate position responsibilities into more useful information-user requirements.

4. Raise the consciousness of the origin of information requirements and how information supports Navy positions. Navy missions are the markets for information systems and the only places to identify values to justify information costs.

5. Provide a continuing highly qualified supply of personnel for professional work in Navy information systems. In addition, progressive course work and training for users of NIS can be accomplished through NIS position classifications, NIS education and training, and manpower planning.

6. Provide a professional information systems competence for the top-level officers that would be involved in the major issues at this level while eliminating petty assignments that could overwhelm OP-945 staff. Staff support to ASN(FM) and CNO offices, and special project assignments can help attain this.

7. Provide leadership and management of the information systems elements of priority programs and projects that include but go beyond information systems technology. Among the skills needed for new programs and projects are information architecture, information inventory and locator systems, information systems research and development, information-user requirements, information variation and standardization, and word processing integration with information systems, with special attention to the uses of small computers.

8. Compare and evaluate installed technology with projected technology, seeking to balance today's processing needs with tomorrow's processing improvements. This involves analyzing

present and future funding opportunities and limitations by technology assessment, installed equipment assessment, hardware and software trade-off analysis, and data communications and telecommunications studies.

9. Monitor current software development, production, and maintenance, providing policy and guidelines to balance optimum local use of programming skills and common program utilization across multiple Navy installations. Examples are CDAs, user staff, and contracted software.

10. Guide current production operations at Navy computer centers. Given the Navy-wide capacity for ADP processing by installation, policy and guidelines would be developed for periodic need and capacity situation reviews. Consultation to installations would be available from NARDAC operations, other command operations, and facility capacity reviews.

The Navy has the technological skills in NAVDAC and its subsidiaries, the NARDACs, to give senior management the confidence that the Navy's information systems will use the most efficient, cost-effective information technologies available. The following chapter presents the committee's views on how the Navy should deal with the NARDACs in view of the adverse report of the HAC Surveys and Investigations Staff Report, May 1981.

V. WHAT TO DO WITH THE NAVAL REGIONAL DATA AUTOMATION CENTERS

Since their inception in 1977, the seven NARDACs have contributed much to naval information processing in an era of increasing decentralization. Despite this, NAVDAC has been criticized for the levels of service delivered to some of the major users of the centers.

As a consequence, the Surveys and Investigations staff of the House Appropriations Committee had proposed, as its first suggestion for resolving the Navy's ADP management problem, the realignment of NAVDAC, and, by implication, the NARDACs under CNM. Early in the study, the CNM proposed that the committee look at a variation of the HAC suggestion that proposed realigning only the NARDACs under CNM.

The seven NARDACs in Washington, Norfolk, Jacksonville, Pensacola, New Orleans, San Francisco, and San Diego are managed by NAVDAC and staffed with military and civilian specialists in operating systems, database systems, microprocessors, and computer performance optimization; the centers provide a valuable and needed service to other Navy commands. Each center contains large-scale data processing and data communication equipment, and provides computing service as well as software development support to the customers it services in its region. Though the equipment and services are not completely uniform, each center supports a different mix of customers. Five centers do, however, contain mainframe equipment by Burroughs and Sperry.

In addition to ADP services, the NARDACs are focal points for technical support and will have an increasingly important role as the primary field activity of a technical command. As a further benefit to the Navy, NARDACs demonstrate economy and uniformity of equipment to congressional committees and oversight agencies.

Rationale. NARDACs were established primarily to provide uniform and professional management of the large-scale facilities. In addition, NARDACs were to realize hardware economies of scale and provide an organizational framework for designing, developing, and maintaining standard Navy automated systems. At all locations, NARDACs provide computing equipment and experienced technical ADP talent that help both large and small users get the most from automation.

A typical NARDAC may serve fifty or more user organizations in its local region. At most centers, a few large users make up much of the workload; some users have data-entry equipment in their own facilities and use the NARDAC to process collected data.

Organization. Most NARDACs contain the following organizational components:

1. A data processing installation (DPI) department operates the computing equipment, monitors its use, makes plans and implements changes in installed capacity, provides production

control and other direct user support, and performs necessary data security functions.

2. A data-processing programming support department (DPPSD) consists of programmers, analysts, and specialists who design, develop, and maintain application software. Systems assignments at the different NARDACs support the local area and, therefore, vary widely. However, much of the software developed at the NARDACs is unique to its locale, though the using command may support a CDA located elsewhere.

3. A technical support department (TSD) consists of analysts and specialists who support the center and the applications programmers in such disciplines as operating systems and data communication software, ADP security, programming languages, and performance analysis and configuration planning. They usually represent the highest skill levels and are in short supply because their specialties require extensive training.

4. Support groups include a controller's office, a management staff, and a liaison planning office to act as a point of contact and to conduct special studies.

Status. Each NARDAC is now operating close to capacity. When a center's service levels fall below the predicted standards set for a class of ADP service, the center initiates procurement activity to add additional capacity. The delay time between sensing the need and adding operational equipment is cited as the major factor in the almost continuous state of saturation. The user organizations are not the direct resource sponsors for ADP equipment, that is, they don't acquire the equipment. This results in a split between those who generate the need for additional service and those who must meet the need with added computing resources.

Most NARDACs derive a major portion of their use from a nearby NAVMAT activity. It is not surprising, therefore, that NAVMAT believes it should have direct organizational responsibility for operating the computing equipment. Moreover, with such a transfer of responsibility NAVMAT contends that it could be a more effective advocate for assuring needed capacity expansion.

The opponents of NAVMAT's proposal to give NAVMAT the operating control over the regional centers maintain that the smaller users outside of CNM's reporting chain would not receive equal service. They argue that the present NAVDAC organization is motivated to run the NARDACs as true service centers, and further, that a uniform service concept would be difficult to maintain when a center's management and major user are one and the same.

Aside from the capacity problems that impair service, NARDACs have not, until recently, operated the latest equipment. Upgraded equipment and operating systems now being installed will permit more networking and thus improve the ability to spread workload. At present, the centers do

not operate as part of a true network. But with additional investments in communications software and specialists, NARDACs are progressing toward that goal.

Beginning in fiscal year 1984, the NARDACs will be completely funded by NIF, the Naval Industrial Fund. When that transition is complete, they should be able to continue to justify improvement in capacity because costs for equipment, facilities, supplies, operators, and support staff will be offset by revenue from the sale of ADP services. The capacity and staff at each regional center can then be adjusted upward or downward in line with user demand.

Capacity problems have lowered the levels of service of the NARDACs in recent years, but appear to be nearing an end. Under a contract that provides for a broad range of capacity options, the centers are upgrading their Sperry mainframe equipment with sophisticated central processors. The new systems will have capacities to meet existing demand and may increase in power, by incremental upgrades to the central processing unit or the input and output subsystems, without the need for exchanging entire mainframes.

With the new-generation equipment, all the processing power of a NARDAC can be spread among separate systems of differing sizes rather than confined to one or two large mainframes. It may become economically and technically attractive to dedicate an entire system to one large user, using other systems to share the workload of many smaller users. In this way, the large users enjoy the advantages of running under dedicated systems free from competition, while avoiding the added costs of running and staffing their own facilities. The ability to choose the most responsive and cost-effective service will become available.

Benefits of the NAVDAC relationship. Under NAVDAC, the seven NARDACs and their satellite data centers have made significant progress in responding to increases in workload and improving the quality of services delivered.

Physically, technically, and even politically, the data centers benefit from the reporting relationship to a specialist command. Because NAVDAC's mission is primarily data automation, the technical specialists assigned to the regional centers have a better chance of recognition and career growth than in a non-ADP command.

Since coming under the control of NAVDAC in 1977, NARDAC facilities have been improved and updated. But much work remains to bring them up to modern standards. In an environment of budget austerity, military construction projects are highly competitive for resources. But NAVDAC is an ADP specialty command and can improve its facilities without compromising other claims on its resources. Had NARDAC been part of a non-ADP command, facility improvements to date and improvements now in progress, such as uninterruptible power supplies and improved physical facilities, could have been more difficult to secure.

NARDAC specialists can design, develop, and operate software systems that can be installed uniformly in centers that are too small to justify having their own CDA. This can be particularly beneficial to the small user who requires the same capabilities as a larger user.

Results of transition to industrial funding. Currently, funds from NAVDAC pay most of the costs of running the NARDACs. In recent years, rate structures were established to enable some of the NARDACs to charge customers [for example, Naval Aviation Repair Facility (NARFs)] that are themselves industrially funded, and thereby independent of any mission support. At most NARDACs, however, income from the charged services covers only a part of the operating budget.

The NIF funding is perceived as having two advantages: One, users of ADP services become more cost-conscious in their demand for services once they are made to pay for them. Two, the centers themselves increase the installed capacity and staff as demand arises, because the industrial fund can be treated separately from the NAVDAC mission, which must support many other activities. The NARDACs will be made more aware of the need to operate efficiently if placed in competition with commercial suppliers of ADP services.

The Navy must address several issues of NIF funding: The first transition from mission to NIF funding will direct greater attention to the costs of computing. The rate structure will contain some elements of overhead or general costs, such as management and administration at all levels, including those at NAVDAC headquarters. To gain relief from mission-funded constraints, there may be some temptation to expand the number of headquarters or staff personnel in the overhead base. Yet loading the NARDAC overhead staff could drive ADP rates higher than those of commercial services, and users might be tempted to take their work elsewhere. As a result, centers would lose income and be forced to reduce capacity or staff.

Three sources will provide funding for the technical support at the NARDACs: (1) the technical support department of the center for direct support of the ADP operation, (2) billing time directly to users, and (3) billing time to NAVDAC-sponsored projects.

As the transition to industrial funding takes place, the new rates must be tested. This assures adequate income at each center. Experience has shown that at least two years are needed for the desired stability. For the duration of the test, which should take no less than two years, present users of the centers should continue giving their work to the NARDACs. This will enable the NARDACs to build the necessary staff levels and stabilize the equipment capacity. Even beyond this transition period, though, the Navy should carefully review any major work that is moved out of the NARDACs to ensure that their existence is not threatened. Indeed, the stability of the technical staffs and not just the ADP operations must be protected. As the Navy implements improved information systems, technical staffs play a decisive role in concept, demonstration in prototype form, and adoption in the field. NAVDAC will

have to assume the important responsibility of technology transfer to promote and demonstrate new applications of information systems. OPNAV must assure, through NAVDAC mission funding, that the field organizations build critical mass and maintain momentum.

Recommendations

The committee recommends that the NARDACs should be retained and strengthened under a specialty command such as NAVDAC. The NAVMAT proposal to transfer the NARDACs to NAVMAT control would not be to the Navy's benefit. This recommendation will result in the following:

- The NARDACs represent a valuable, in-place resource for efficient, large-scale computing that is useful to Navy shore commands in all domestic locations. NARDAC services can be made uniform across all the centers. By using the nearest NARDAC, users that are spread across multiple locations can receive identical service.

- The NARDACs represent a field activity from which NAVDAC can offer a wide range of technical services in addition to computing. Technical expertise can be offered to Navy commands that need the help of ADP specialists in systems programming, data communications and networking, microcomputing, office automation, computer performance evaluation, and facility preparation. The technical experts in these areas are among the most highly trained in the Navy; they are difficult to attract and retain, and they work best in a specialist command that recognizes and supports their accomplishments.

- The investment in building, staffing, and improving the NARDAC computer facilities has been substantial and will (and must) increase as the demand for service continues to grow. As the centers move to industrial funding, the needed resources can be justified and acquired more easily by retaining the centers under a command having no internal competition for investment.

- In almost every NARDAC, one or two large-demand user organizations make up a major portion of the workload. Until recently, this has created difficulties in servicing both small and large users, especially when the systems were run close to capacity. The NARDACs can now acquire systems flexibility operating separate systems dedicated to a large user and, at the same time, operate other systems of the shared service for the smaller user. This is made possible by the improved equipment now being installed.

- Because the NARDACs represent the field locations for most of NAVDAC's technical personnel, they will take on additional importance under NAVDAC mission funding, as the proponents for demonstration projects in new technologies, such as office systems, microprocessor applications, and local area networks.

Using technology transfer funding from NAVDAC, in cooperation with a local user, a lead NARDAC might develop a new system that would serve a current need and also become a model for implementation in other locations.

The next chapter presents suggested guidelines for developing a structure, an architecture, that will integrate the Navy's organization, management roles, planning process, and technology capabilities to meet the information needs of the Navy's top-level management.

VI. GUIDELINES FOR AN ARCHITECTURE PROJECT

It is the tradition of the Navy to make decentralized decisions. By contrast, Navy computer installations are centralized. Today, as hardware and software costs decline and as easy-to-use, smaller computers become available, there is a general movement toward dispersing computer services.

Although there are advantages when users design and operate their own computer services, activities worthwhile to a local operation can in fact be detrimental to the system as a whole. Different hardware, software, communications options--even different inputs and outputs--make it reasonably difficult to integrate information services. It is becoming evident that there must be trade-offs, a balancing of local needs with the needs for the entire Navy.

Setting up a structure for coordinating and integrating information systems is known as "corporate-level architecture." Generally speaking, the term architecture refers to a description of the structure of a system, showing the way its parts fit together. Information architectures are special systems that provide descriptions of information requirements and data processing logic. They identify the parts of a system, the functions performed by these parts, and the interfaces between them.

The architecture seeks to coordinate and integrate various systems to contribute to accomplishing managerial (organizational) objectives. This top-level view is derived from and, consequently, is consistent with lower-level views. A second level describes subsystems in greater detail, including data elements, data structures, internal data flows, and processes. At this level the major focus is on the functions performed by a subsystem. A third level consists of data formats, data layouts, and communication protocols; the major concern is the physical transfer of data.

Because the Navy depends on many employees and many documents, attempts to improve the NIS architecture must build on people, files, and records, rather than replace them. The need for a NIS architecture increases as computer use and dispersion continue. An architecture at the CNO level will serve not only the needs of headquarters, but also provide guidance to the field. The policy to develop and use a high-level architecture for NIS can be a powerful force for improvement. Moreover, an organized effort to reap the benefits of the architecture also has psychological benefits. As teams are brought together to work on common problems, coordination between them becomes automatic.

Over many years, the Navy has put many information systems into operation. And each system always contains more detail than was expected. But because documenting the content of these systems has been given a low priority, the resulting systems are difficult to use and difficult to revise. What's more, no strategy exists for attacking this deteriorating situation.

A comprehensive NIS architecture should describe who is responsible for achieving which objectives and who is to report to whom. In addition, the architecture should describe the mission goals of each component, determine the information necessary to meet the goals and objectives, and establish a standard language that everyone could use.

The phases preliminary to determining the general logic of individual systems may need several levels of description. These would range from general logic diagrams to the precise machine codes for operating a particular system. Considering a variety of systems and tracing their interfaces may also be desirable. The architecture can be used to integrate the systems effectively and to pinpoint unnecessary repetition throughout the systems.

Another part of the architecture describes factors such as the technology and the correlation of the equipment and software and also the geographical mapping of organization locations, communications centers, and flow of data. Planners must decide whether to make the description general or specific. Not every factor will be important all of the time. To select the priorities and limits for the architecture, the project leaders must decide who specifically will benefit from a specific interaction and how it will help them. The user may want a description of the options of the current architecture and a general specification of the future system. The designer can use the specification to convert the current system and possibly allow for future additions.

Organization of authority is important to top-level management. Technology is more the responsibility of the technical staff. The architecture must fulfill both their needs. Whom the architecture serves, however, is up to the management.

The architecture menu might be viewed as a matrix showing the content variables and their status (Table 1). This menu would indicate the content of the NIS architecture. Because it would show both what is and what isn't in the architecture, it would prevent overexpectations.

TABLE 1: NIS ARCHITECTURE MENU

	Life Cycle		
	Description of Current Situation	Description of Desired Situation	Description of Redesign Effort
1. Organization's authority structure	X	X	X
2. Objectives, missions, and functions	X	X	X
3. Information requirements	X	X	0
4. Systems by name only	X	X	0
5. Systems general logic	X	X	0
6. Systems explicit logic	0	0	0
7. Systems multiple interfaces	0	0	0
8. Hardware, software, and data communication	0	0	0
9. Geographical mapping	0	0	0

BOTCAP Committee Recommendations:
X = Include in CNO-level architecture; 0 = Exclude from CNO-level architecture

An architecture for NIS must be conceptualized, built, tested, and put to use. This architecture can

1. build confidence in NIS quality and availability;
2. decide where NIS resources should be allocated;
3. meet requirements of laws, regulations, and directives;
4. identify user needs;
5. reduce redundancy and duplication of systems;
6. facilitate systems redesign, particularly when studying system interfaces;
7. support the development of standard flowchart logic for some output requirements;
8. support the development of standard names for data elements;
9. drive database management systems and data processing; and
10. improve coordination within the Navy for giving and getting specific information.

Recommendations

The architecture project is essential to the success of NIS. Top Navy management should lead this effort and monitor and support its development and application. The following points should be kept in mind:

1. NIS architecture justifies a high-level, continuing effort. It is not a one-time project. The Navy should make it a mission of the NIS division.

   The architecture for the CNO would de-emphasize multiple interfaces, hardware, software, data communications, or geographical mapping. It is assumed that field commands, COMNAVDAC, for example, would provide this information as needed.

2. Most of the redesign efforts should not be part of the CNO architecture, but assigned to the field commands or agencies. The field could develop its own architecture within the context of the CNO-level architecture.

3. The Navy should pay particular attention to the relationships between the selected options. But choosing the content options for the architecture is not the only concern, information requirements must be derived from a set of objectives, missions, and functions. The architecture project should study the problems of conversion from information requirements to systems general logic.

4. NIS architecture at the CNO level must be related to the top-level, broad strategies and plans for the Navy. Navy strategy statements and planning documents are the basis for preparing information systems strategies and plans. The documents spell out the improvements the Navy wants to make in the next few years and can be extended into more specific goals, tactical plans, and specific projects.

5. The information systems strategies and plans map what changes should be made in the near future to implement NIS. The CNO-level architecture should answer at least these three questions: What information is needed? What information is available? What information is not available and should be?

6. Top Navy management should be able to look at the content of the architecture and see descriptions of current strategies and plans, types of information available, and places to get different types of information. The architecture can, in effect, be a special system driven by top-level strategies and plans and that, in turn, drives information systems planning and control.

7. Top management (especially OP-090, Director of Navy Planning, and OP-06, DCNO, Plans, Policies, and Operations) should be responsible for deciding current strategies and plans.

8. Information systems staff, especially those trained to identify information requirements, should be made responsible for getting the available information.

9. Both top management and information systems staff should work together to translate strategies and plans into information systems requirements.

10. A lot of materials will accumulate in the process of documenting strategies, plans, and information requirements. These data should be stored and kept up to date to facilitate retrieval. Experience has shown that a staff member or a group should be assigned this responsibility.

11. Someone should be assigned to look at the variety of information systems, their flow logic, and their systems for naming data elements. At some point, there will be language and vocabulary problems. Classifications for Navy activities and missions should be analyzed and standard terminology developed.

12. The architecture project should be given a chance to develop and to run tests. Reasonable involvement of Navy executives is the best assurance that the architecture project will succeed.

At some point, commanders at other levels of the Navy should be shown the content of the architecture. This will give them specific guidance for missions and mission-driven information systems.

To coordinate and integrate information systems, it is especially important for local commanders to know exactly where they have discretion and where they must defer to standards set at higher levels. Because CNO-level architecture does not go into explicit detail, the field commanders should have careful, up-to-date documentation of systems logic. CNO-level architecture should, however, tell the field commands

how to develop and maintain the required documentation of their systems. This is the only way to identify similarities in systems across commands.

Ideally, each major command would develop an architecture that services its own organization. The command-level architecture would be compatible with the CNO architecture, but should be more explicit in descriptions of systems logic.

The project will have to study carefully the reasonable local options for hardware, software, communications, and terminology. With better architecture information at the CNO level, the field commands can at some point assume the burden of proof for justifying local options. The architecture project should develop rules to evaluate local requests. The Navy can then be assured that local initiatives will continue and will conform to the corporate-level architecture.

VII. NAVY ACTIONS TO DATE

As of the publication of this report, the Navy states that it has instituted the following changes in line with their estimate of what their senior managers believed the final recommendations of the BOTCAP committee would be.

ADP procurement. The ADP Selection Office has been shifted from the Naval Data Automation Command to the Naval Material Command. This organization move consolidates the procurement of ADP equipment and services with all other goods and services procured. By bringing together all the Navy's procurement experience and expertise with what it has learned about ADP procurement, the Navy expects to shorten acquisition time of ADP.

Information systems focus in OPNAV. On 1 August 1983, the Director, Command and Control (OP-094) created a new division devoted to information systems and information resources management. In this new division, the Director, Information Systems Division (OP-945) is charged with developing policy and providing oversight on information systems, and combining the previously separate ADP with word processing. On 15 January 1984, the rest of the responsibilities for information resources management were added. The new division emphasizes the following: information and information systems, rather than ADP hardware; validation of information requirements as the first step in review of information systems proposals; and programming and budget structures as the prime vehicles for the division's management.

Information systems architecture. Architectures have been completed for Active Duty Military Pay and Reserve Pay, and are under development for General Accounting and Manpower, Personnel, and Training. In each case, the architecture emphasizes user involvement at the executive level, and all the architecture studies have focused on information flow and functional information requirements instead of automatic data processing. The Vice Chief of Naval Operation and Comptroller of the Navy, as well as the pertinent functional managers, have, as an example of this new focus, approved the completed Military Pay architecture.

Planning. A conference held 31 October through 10 November 1983 reviewed suggestions for component planning and changes needed in the planning structure for the project. The meeting was attended by higher-level functional personnel than in previous planning meetings. The conferees claimed to have made considerable progress in understanding planning requirements, coordinating similar developments, and exploring needed changes in the planning instruction. They recognized the need for closer ties between planning and programming, and scheduled the early 1984 issue of the Information Systems Plan for fiscal years 1986 to 1990, a strategic plan, and a revised planning instruction.

Human resources. The Director, Information Systems Division (OP-945), chairs parallel boards on civilian and military career management in data processing. The civilian board has recently approved

submission of a proposal to the Office of Personnel Management to create a new series definition of computer engineer and broaden the series definition of computer scientist to make it less restrictive. The first meeting of the military career board was held in May 1984. A recent conference in Monterey, California, has already looked into the possibility of a curriculum change at the Naval Postgraduate School to better support software engineering.

Standards. All major segments of the Navy attended a Standards Seminar held in September 1983. They participated in formulating a process for developing standards all across the Navy.

Service center (NARDAC) improvements. All NARDACs and all centers are now linked in a network and have newly installed UNIVAC 1160s, with state-of-the-art processing capacity. In addition, a military construction project (Milcon) has been funded for one center in 1986. After that, additional centers are programmed with the final four scheduled for fiscal year 1990.

Technology leadership. A major omnibus contract for microcomputers was signed in conjunction with the Air Force in September 1983. This cooperative effort is a milestone in encouraging the use of properly specified microcomputers within the Navy. A further Navy-wide microcomputer workshop, the third, was held in April 1984. Meanwhile, efforts continue with developing cooperative contracts with the Air Force.

Policy changes. Life-cycle management policies and procedures are being revised to reflect the current status of word processing, office automation, and information systems as one entity. This will dramatically simplify the approval process. The revised instruction is currently being staffed; publication is expected late 1984.