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FROM OPERATIONAL NEEDS TO NOTIONAL SHIPS - A NEW LOOK,(U)
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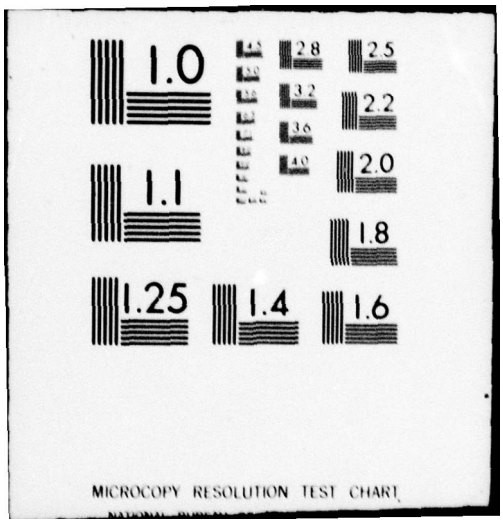
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(6) FROM OPERATIONAL NEEDS
TO NOTIONAL SHIPS
- A NEW LOOK

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The views expressed herein are the personal opinions of the authors and are not necessarily the official views of the DOD or of a military department

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ABSTRACT

The purpose of this treatise is to contribute to the improvement of ship acquisition in the U.S. Navy by presenting a new look at the early stages of ship development and suggesting that certain management tools be applied. The thrust of the recommendation for management improvement is the attainment of a positive and orderly Pre-Acquisition Phase with the central theme of Integration. The lack of a coordinated effort to systematically examine operational needs and to assimilate the results of studies and ongoing developments creates a situation in which needs, gaps and/or shortfalls are not identified until a ship conceptual design begins. The result is that in many cases the products of development programs cannot meet the production schedule of the ship which prompted the development.

For approximately two years the Naval Sea Systems Command has been involved in the Notional Ship Development (NSD) program; that is, a routine system to identify the mission essential subsystems of planned advanced ship systems prior to the conceptual design phase. This system aids in the establishment of a Needs Base Line (NBL) which sets the stage to begin the conceptual design phase which terminates with a Conceptual Base Line (CBL). A computerized NBL data bank has been established at the David W. Taylor Naval Ship Research and Development Center. The principal elements in the data bank are a catalogue of operational needs and pertinent information concerning R&D projects. Both needs and projects are matched with applicable ship/craft and the integration agent is in the form of OPNAV approved Sub-Operational Capabilities (SOC). The new look stresses using existing tools such as the NAVSEA Ship Work Breakdown Structure (SWBS) and OPNAV SOCs and improvising improvements within the present system.

The Notional Ship Development program is not presented as the solution to all ship acquisition problems, but is aimed at improving the pre-acquisition phase. However, the success of each function of acquisition depends in great part on how well the preceding function was accomplished. It is submitted that each player in the acquisition process can gain by supporting and using the program.

There are many problems yet to be solved and much data to be collected and analyzed. The program is considered a dynamic, evolving management tool which has something to offer for all and the potential to greatly improve the ship acquisition process. To be useful it must be used; to be used it must be accepted; to be accepted it must be understood, if not in whole, certainly in specific areas of application.

A. INTRODUCTION

1. PURPOSE

The effort described in this paper has but one goal, to contribute to the improvement of ship acquisition in the U.S. Navy. Since the primary mission of NAVSEA is the acquisition of ships and craft, with appropriate combat systems, for the operating forces of the Navy, this paper is written from a NAVSEA point of view and dwells primarily on aspects of the early phases of decisions for ship acquisition. To establish a common base for departure, a simplified summary of the what, why and how of ship acquisition is presented by the following hypothesis:

A. INSTALLED SHIPBORNE EQUIPMENT/SYSTEMS, which
B. PROVIDE OPERATIONAL CAPABILITIES, at
C. CURRENT PERFORMANCE LEVELS, have
} [STARTING POINT]

D. OBSERVED DEFICIENCIES, or
E. POTENTIAL INADEQUACIES, which require
} [OPERATIONAL NEEDS]

F. RESOURCE ALLOCATION, or
G. ENGINEERING ADAPTATION, or
H. DEVELOPMENT, to
} [RESPONSIVE SOLUTIONS]

I. REPLACE, or
J. IMPROVE CURRENT OPTIONS OF SUBSYSTEMS, for
K. NEW CONSTRUCTION, or
L. MODERNIZATION OF NAVY SHIPS
} [MODE OF APPLICATION]

In the past needs have not been catalogued so that they can be readily identified and compared with both ongoing developments and inventory equipments to optimize resource allocation or to reveal gaps or shortfalls. As a result, Pre-Acquisition planning is not as timely nor as selective as it should be. The relevance of needs to R&D projects and to inventory equipments is not comprehensively addressed due to inattention of management to valuable information.

At present the early development efforts involving the ship are conducted separately from the development of subsystems. An earlier integration of both development efforts could decrease acquisition time and could increase efficiency of design. Not only is earlier technical integration important, but also, an earlier integration of development time schedules could greatly enhance ship construction planning.

There is currently no systematic approach to correlate the results of studies aimed at formulating a coordinated NAVSEA development program. Many R&D managers along with their technical consultants in other Directorates, Laboratories, and Industry, are individually studying the need for the constraints on, or the application of, their particular fields of interest. These valid explorations eventually influence the direction of R&D planning. Their impact on other fields of interest are taken into account to the degree that the study director understands or desires. The affected areas may have no knowledge of the potential impact unless an objective management control system is set in motion.

Another serious void in Pre-Acquisition planning is the absence of an organized needs/requirements index with accompanying performance data required to fulfill the need. The threats posed by anticipated enemies of the U.S. create technical needs for combat ship systems to neutralize or destroy those threats. CNO examines the needs and (eventually) establishes Operational Requirements (OR). These OR constitute the prime driving force for <u>implementation</u> of developments, but all known needs should be considered earlier and addressed in the development <u>planning</u> process.

New developments are influenced not only by the requirements "pull" but also by the technology "push". New technology is continuously emerging and existing technology is constantly changing. Developments which evolve independently of requirements pull must either satisfy an existing need or create a situation in which new needs emerge. Allocation of R&D resources traditionally has reflected, to some degree, the success of various program advocates in "selling" the program in which they are interested. This is not to say that the programs being supported do not address a need, but rather to point out that there may be proposals which do address critical needs but are not being supported because they lack a dynamic advocate.

The authors intend to discuss the tools for the management of a positive, well planned <u>Pre-Acquisition Phase</u> with a central theme, <u>Integration</u> of elements A through L of the hypothesis.

Display 1 contains a summary of events associated with ship development and presents an outline of the overlap of Pre-Acquisition (as defined by the authors) with the Conceptual Design and Preliminary Design Phases[1]. "Acquisition" (as defined by the authors) commences when an alternative is selected by CNO from the Development Proposal[2] (DP) and the funding of that option is approved by OSD and Congress.

Although the Pre-Acquisition Phase encompasses those activities preceding the response to funding requests it is in the shaded area of Display 1 that the authors will concentrate their approach to the theme of Pre-Acquisition Integration. The shaded portion depicts no events at the SYSCOM level because, although there are planning actions taking place, they are not consistent, routine, or coordinated.

NAVSEA is continuously engaged in a dialogue with OPNAV both prior to and after the issuance of the Operational Requirement (OR). NAVSEA plays an important role in the formulation of the Top Level Requirements[3] (TLR), the Tactical Operational Requirements and the base lines associated with the ship design process. The ability to provide this kind of support relies upon those very early activities not identified on charts such as Display 1 because their contributions are not recognized nor appreciated; e.g., analysis of subsystem needs independent of ship development.

Display 1 begins with appraisals of threats and identification of needs by OPNAV. Parallel to this, preparation must be made in NAVSEA for potential technology solutions to operational problems. In order for SYSCOM R&D (ship design) managers to devise (ship) Development Proposals during the Conceptual Design Phase, they must possess substantial knowledge of operational needs prior to receiving an Operational Requirement for a ship.

The OR appears as the signal to take advantage of the analyses of alternatives and developments which have taken place (it is time to make a decision on the configuration of a new ship).

The alternative ship systems listed in the Development Proposal (DP) must be responsive to the mission expectations in the OR, and the subsystems defining alternative ship systems must already be developed or near completion. Obviously R&D program managers must have conducted earlier analyses in their assigned areas to support proposed development programs.

The process of Ship Pre-Acquisition involves a set of sequential and parallel activities, each of which requires resources and is a sub-process. The successes of these activities depend upon the adequacy of funding and the capabilities of participants.

Each sub-process activity has a set of tools and products which ideally is designed to fulfill objectives efficiently and to provide information effectively to other sub-processes.

The total process is not under the control of one organization at the decision level, and therefore is not expected to be thoroughly coordinated. An independent view of how the pieces fit together has led to the observation of opportunities for improvement to be discussed.

The foregoing hypothesis in an interpretation of a practical situation to manage the process more efficiently. The primary aspects of attempting this are predicated on (a) knowing who the participants are, (b) understanding their roles and how they are implemented, (c) determining what would be worthwhile to change, and (d) convincing the participants to utilize the changes.

This paper does not advocate re-inventing the wheel. Rather, the approach of the authors is to take a new look at the early stages of ship development and to advocate improvements within the present system. The success of each function of acquisition depends in great part on how well the preceding function was accomplished. Weak initial planning results in gaps and/or shortfalls in development programs. Development programs which do not satisfactorily address operational needs result in ship and weapon system designs based on alternatives which do not represent the best selections and are therefore very costly.

Pre-Acquisition functions performed before the OR is issued are equally the responsibilities of OPNAV, NAVSEA and others. Each must participate in those activities which ensure effective long range planning for development and design. If NAVSEA were to react only by planning development after an OR is received, the acquisition process would take several more years than it takes now. The lack of a coordinated effort to examine needs systematically and to assimilate the results of studies and ongoing development efforts is reflected in the current problems in Pre-Acquisition planning efforts.

2. BACKGROUND

In order to set the stage for an approach to improve ship acquisition by defining an orderly comprehensive Pre-Acquisition Phase, it is appropriate to review current practices and a brief history of the evolution of the effort. Several years ago a planning tool was developed which organized R&D projects with their applicable ship systems into matrices. These matrices were published in the Advanced Ship Systems Development Planning Manual[4] and included descriptions of ships and R&D projects with pertinent data and major milestones of ship development. The manual was designed to aid ship development managers ascertain "advanced alternatives" in subsystem selection However, it became apparent that, because of time constraints, the ship development manager could choose only from "off the shelf" subsystems and equipments. The Ship Planning Manual also brought to light that there are shortfalls in many areas which were not being satisfied by development of new subsystems.

On the positive side, the discovery of shortfalls results in the initiation of new developments. On the negative side, development time is normally too long to permit a new product to meet the schedule of the ship program which prompted the development. This "catch up" process (see Display 2) is unacceptable but can be improved (a) by ensuring an

awareness by all ship development participants of the subsystem developments underway and those proposed and (b) by ensuring an awareness by all subsystem development participants of the operational needs (and capability performance levels) of developing ships. The Ship Planning Manual was designed to make planners aware of all developments and was periodically updated to reflect current developments in both ships and subsystems.

It became more and more obvious that ship and combat systems acquisition programs had many managers making decisions concerning a myriad of items and that there was no central source of information from which managers could find a common departure point.

In view of the deficiencies just described in the current Pre-Acquisition and early Acquisition phases of ships and combat systems development, there is a definite need[5] for a positive planning tool. The current relationships between groups of people who deal with each other in the normal course of Navy business are not the targets for improvement to be discussed here. Rather, the realization that disconnected groups eventually are contributing to Navy goals beyond the purview of individual groups demands that "super" integration be given serious thought. It is recognized that interfaces between dispersed groups require continuous attention. Hopefully this paper will be taken as an invitation to participants to become identified with this effort and to improve the interpretation of their involvement as presented. The sampling of on-going "mechanisms" investigated thus far will be described only in-so-far as necessary to integrate their objectives and input/output.

B. APPROACH

1. THE NEW LOOK

The preceding description of the current pre-acquisition process and R&D planning procedures points up several areas in which improvements are mandatory. Starting in 1974 funds were allocated for a Notional Ship Development (NSD) program. A "Notional Ship" is a concept which exists prior to conceptual design and ceases to exist when design commences. It is more specific than "generic" ships such as "submarine" or "destroyer" but less specific than a ship described by a TLR. It is described by words and numbers rather than by pictures. Its description relies on knowledge of ships previously built in the same generic category and utilizes the same information structures applied to previous ships. The anticipated mission and the subsystems/performance levels describe the notion. Display (2) shows the time relationship of NSD to acquisition funding. The NSD program defines an approach for identifying the mission essential subsystems of planned advanced ship systems prior to the conceptual design phase. This NSD system provides the "New Look" approach which we will now discuss. NSD aids in the establishment of a Needs Base Line (NBL) which sets the stage to begin the conceptual design phase which terminates with a Conceptual Base Line[6] (CBL). The program is intended to provide back-up information and data for conducting an improved pre-acquisition process. It also is intended to be an easily updated system so that as the preacquisition process envolves with more modern and sophisticated techniques, the data contained in the system and the associated information storage and retrieval tools can be modified to maintain their usefulness. Specifically, the system is being designed to the following objectives:

- Identify, index, and maintain current a data base of all the needs, deficiencies, or shortfalls of the operational Navy forces to assist in R&D planning and in study evaluations.
- Provide and maintain current a data base which can be used to accumulate and correlate the results of all ongoing and proposed studies of new ship system and subsystem developments.
- Provide a sound base for establishing priorities of ship system or subsystem development.
- Establish and document performance criteria for ship ship systems and subsystems.
- Provide a continuous and systematic review and analysis of the relationships between operational needs, inventory equipment capabilities, and the capabilities of subsystems resulting from planned R&D efforts.

- o Contribute to the accomplishment of earlier technical integration of new systems and subsystems into new or improved ship designs.

- o Provide the means to achieve earlier integration of ship system and subsystem development schedules.

- o Provide timely inputs on a routine schedule as well as on an as-needed basis to the Fleet Modernization Program (FMP), Ship Acquisition Managers (SHAPM), and R&D Program Managers (PM).

2. THE DATA BASES

Throughout the discussion one fact has been continually emphasized; namely, no complete and organized listing of the operational Navy's needs exists, and without such a listing, no coordinated and comprehensive analyses can be developed for use in the various decision-making processes. The first step toward implementing the Notional Ship Development concept was to conduct a thorough and systematic effort to identify and to assemble in one place all the OPNAV-level documents containing officially recognized statements of operation needs, deficiencies, or shortfalls. This collection effort identified some 300 documents, summarized in Display 3, to be surveyed for statements of operational needs. Although only 14 line items are listed in the table, note that some are compilations of numerous other documents. The magnitude of the number of other documents collected substantiated early predictions that the volume of data to be accumulated would surpass human capabilities to maintain order and that a computerized data storage and retrieval system would be absolutely necessary. A characterization system is also required to describe each data entry so that information pertinent to desired objectives can be recognized by the data retrieval systems and subsequently provided in a useful and organized format. As each document was surveyed and needs or deficiences were identified, the following data were recorded:

- o Document title, section (or chapter), and page number,

- o Ship Type (or category) to which the need applied, and

- o Priority assigned to the need (if given in the document).

The statement of the need was paraphrased as accurately as possible so that the statement would fit on a standard computer card.

Each need must be further characterized by some system whereby needs of similar nature can be automatically associated. The concept of sub-operational capabilities (SOC) (see Display 4) was chosen as the basic descriptive element to be used to characterize the operational needs since it is in wide use within the Navy, including:

- o NWIP 11-20, in which the intended mission of each ship type within the Navy is defined,[8]
- o FORSTAT, the system for reporting operational force status and readiness to perform assigned tasks,[9]
- o ROC, the definition of the required operational capabilities[10] of each ship type based on the statements in the approved characteristics,
- o TLR, Top Level Requirements,[3] a basic design concept paper for new or improved ship designs, and
- o OPTEVFOR" evaluations of new systems/subsystems.

This structure fits very well into the scheme since R&D programs as well as inventory systems and subsystems can also be associated by SOC's. Finally, all the extracted data relative to operational needs were punched on standard computer cards and stored on a magnetic tape as a permanent, but updatable, operational needs data file.

In an analogous manner, R&D project data were similarly assembled, characterized, and stored on magnetic tape. Projects included all NAVSEA currently funded (FY 77) and proposed (i.e., Advanced System Concepts[12] (ASC's), for POM[13] 78, POM 79, and POM 80) projects, and all non-NAVSEA projects which pertain to shipborne systems/subsystems/equipments. The type of data prepared for each project includes:

- o project title and a paraphrased statement of the project objective,
- o SYSCOM sponsor,
- o element number and project number (or ASC number),
- o applicable ship types, and
- o applicable SOC's.

Several retrieval methods have been developed using both the needs data base and the projects data base. The aim of each has been to provide the maximum amount of information in the most concise and comprehensible format possible.

A subsequent realization that certain SOC's, when organized in groups of logically similar SOC's, constitute a definition of an operational "function", led to a useful way to extract needs and projects. The list of functions resulting from this analysis is shown in Display 5. Since both the needs and projects are characterized as to the applicable ship type, needs and projects extracted for a given function and a given ship type produce informative outputs.

The procedure of extracting needs and projects by function and/or ship type works well, but not for all purposes. because of a problem which arose during the initial characterization of needs and project by SOC's. The analysts frequently found that some needs and projects (particularly 6.2 projects and ASC's) could not be assigned obvious SOC's because the scope of either the need, or the project, or the SOC was too detailed or too general. Therefore, some needs and projects were assigned "no applicable SOC". Any extraction or retrieval scheme operating on the basis of the SOC would never extract these items. The necessity for an additional characterization scheme became obvious whereby every need and every project can be positively described.

The new system used for characterizing needs and projects uses the idea of "Function/Performance Areas" (FPA). The FPA concept bears a resemblance to the 2-digit Ship Work Breakdown Structure[14] (SWBS) (see display 6) and the two concepts could be brought into agreement by making some modifications; however no effort has yet been directed toward such a resolution.) SWBS provides a classification system whereby all phases of a ship acquisition or conversion project are identified correlated, and categorized under a single functional index that addresses requirements, material, services, and components. The list of FPA used so far is in Display 7. This FPA list is not all-inclusive, but in keeping with the program concept, it will be developed over time.

It is intended in the future to obtain performance measurement data associated with each need, project, and system/equipment. This would fit into a logical, acceptable, pre-known listing of functional parameters to be commonly used in communicating quantitative data. The fourth digit of the SWBS, or an alternative FPA digit, might accommodate such information now found in the "performance sections" of TLR & TLS[15] or in the "staging numbers" of SECAS. Both needs and projects data bases now have at least one characterization scheme by which each item is extracted (or rejected) through a positive action and not by "default" because the item could not be characterized. A retrieval model was developed to survey needs and/or projects on the basis of these FPA.

3. APPLICATION

The scope of data required to meet expressed objectives of NSD, to be responsive to observed problems in the pre-acquisition phase, together with an anticipated broad spectrum of user requirements, dictated an easily accessible and automated file. This section discusses potential areas of application to assist:

- o The operational user in foreseeing how advanced design ships' capabilities can be used to satisfy future operational deficiencies

- o The acquisition manager in determining whether current research and development is properly oriented and timely funded with respect to other acquisitions

- o The planner in establishing what research and development should be proposed or re-oriented.

The ultimate specific application of the products available from the data file and the associated computer programs can, and probably will, number as many as the number of users. What must be emphasized here is that the out-put obtained from the data base is not the ultimate end of an analysis. It is intended only as an aid to the analyst, e.g., to guide him to the location within the various documents wherein official Navy statements/information may be found. By following this route he will more than likely locate additional backup material that will advance and enhance the ultimate analysis. If the full potential of this approach to planning and development is to be realized and have a beneficial impact on acquisition, all potential areas of application must be visible. Unique application possiblilities exist from the OPNAV level through the SYSCOM level to the technologist/engineer level. Several possibilities of application are discussed below:

a. OPNAV SPONSOR

Display 3 lists source documents used to identify the NBL needs and their relation to R&D projects. Because it is customary for the originators of these documents to permit or solicit review of their drafts, and even invite comments in the published version, there exists an opportunity to provide OPNAV sponsors with the content of the NBL. It can be customized to their mission in terms of the SOC encompassed, and it will provide NAVSEA opinion of the data taken from the OPNAV source, as well as the NAVSEA perception of similar data from other sources which OPNAV might consider for inclusion in their update.

In particular, each mission sponsor[16] ought to be interested in additional pertinent needs, responsiveness of R&D projects to those needs, and identification of equipments/systems expected to contribute to accomplishment of the mission.

A spin-off of this ambition occurs in feedback to the basic instruction which defines missions in terms of SOC[7] used in the TLR. The difficulty which we experience in attempting to comprehend the requirements and to explain the adequacy of the planned ship systems in providing the required capabilities can be reduced by clarification of the mission definitions. New and revised SOC can be suggested to better relate R&D programs and TLS emphases and necessary characterizations.

b. SHAPM/SHIP DESIGN MANAGER

A new ship design effort currently includes preparation of a Master Equipment List (MEL) which initially may be drafted as a revision of a MEL[15] from a previous similar ship. It is an early portion of the TLS which provides some detail of equipments/systems which are expected to satisfy the requirements of the TLR.[3]

When the NBL data base has been expanded to include equipment listings from the Ship Equipment Configuration Accounting System (SECAS)[17] file, a draft MEL would be available, organized by SWBS,[14] based on the ROC[10] of the TLR. It would describe the new ship not only in terms of the options which were selected for installation on all current active ships, with the same SOC assigned, but also in terms of the new options and their schedules made available by current R&D projects. It would also provide a direct correlation of planned equipments in the TLS with the SOC requirements of the TLR including the redundant utility of multi-purpose systems.

This repeatable, comprehensive, fast response print-out of the NBL data provides the opportunity for earlier consideration of alternatives. It is also planned to include data for performance and cost comparisons. Additionally, the "needs" which have not been fulfilled, that is, the remaining inadequacies observed but not overcome will be visible to indicate expected limitations of the new ship.

c. R&D PROGRAM MANAGERS

The current R&D program has been developed, modified, restructured, and rejustified over the years. New starts and stops occur each year. Plans and accomplishments are proclaimed in one-time documentation and in recurring reports. Effectiveness and efficiency are pursued by each R&D manager within the constraints of the resources assigned or sought. This management function includes knowing and formulating needs and opportunities and being aware of changing environments and the relevant efforts of others. The group of people immediately associated with an individual Program Manager (PM) reflect the scope of endeavors emphasized under his purview.

Logic and objectivity demand that the most important needs be addressed, but lack of knowledge and politics limit the opportunity to achieve the ideal. The NBL data base is designed to include those needs and projects addressed by individual managers and to organize them and associate them with other NAVSEA business, namely, ship and subsystem acquisitions. It is intended to offer opportunities to improve the R&D programs by: (1) identifying needs which are not being addressed, but are considered, by some interested party, to be as important as those needs that are receiving attention in the current program, (2) identifying projects/tasks that would overcome noted deficiencies in the program,

and (3) associating all of these with the interested participants and with the individual equipments/subsystems which would increase in value by having their mission capability increased.

d. FUNCTIONAL SUBPROGRAM GROUPS (FSG)

A concept called out[18] in the planning stages of the R&D program for the last two years consists of setting up about 10 or 15 AD HOC groups, each consisting of membership from all NAVSEA Directorates having an interest in a common area. The objective of such a group is to make a comprehensive review of the assigned "sub-program" area, which cuts across PM, Division, and R&D categories, and to recommend to each PM new direction and emphasis/de-emphasis needed.

The NBL data base has been prepared specifically for the purpose of R&D planning. A data summary may be prepared similar to that described for a draft MEL in b above, but expanded to groups of ship types; e.g., all submarines, all combat surface ships, etc. These "Development Needs Tables" would both initiate and record the results of in-depth studies of issues which demand decisions for program direction.

These reviews and studies in effect formulate NAVSEA policy for R&D and form the bases for subsequent preparation of ASC/draft OR, DP, Program Plans, etc., and for use at annual decision periods; e.g., POM/ Budget/Apportionment. The common basis for individual actions assures coordination and a more united NAVSEA image.

e. AD HOC GROUPS

Over the years our methods of doing business have taken new directions, our emphases in missions or technologies have peaked, and our attention to continuing problems has focussed. Each decision to change usually starts with a study of the area of concern which looks at history as well as the occasion for change.

In the R&D business some recent pertinent examples, are:

(1) implementation of MENS[19] & ZBB[20] concepts[21]
(2) emergence of Technical Strategics[22]
(3) formulation of Top Level Requirements[3] and TLS[15]
(4) creation of "Product Lines" at Labs[23]
(5) attention to Survivability
(6) preparation of Science & Technology Objectives[2]
(7) preparation of Proposed Military Improvements[24]
(8) attention to Ship/Subsystem Scheduling[25]

The NBL data is sufficiently flexible to respond to demands for unusual or comprehensive listings of important areas of concern to assist the initial efforts of a new group. Organization and early collection of compilations of data are extremely important when new

direction is indicated and deadlines are imposed. Auditable sources and expressed priorities are valuable assets in such studies. Readily available equipment and project data which can be manipulated to focus on particular interests provide an important tool for AD Hoc studies.

The additional data provided consists of pertinent needs statements, an opinion of relative importance, the related SOC/SWBS areas, the R&D projects and shipborne equipments associated, and the corresponding participants managing, and therefore interested in, the subject areas. Related need statements from several source documents offer expansion or clarification opportunities.

f. ENGINEER/TECHNOLOGIST

The engineers and technicians who assist R&D program managers in the day-to-day execution of project development have in many cases different orientations and fields of interest depending upon their organizational situations. In fact, they may be involved with several PM's and with several SYSCOMS. This condition requires the engineer to have a unique interest in one or more projects and knowledge of the total team effort involved in the R&D program formulation and/or application.

The structure of the NBL data includes the identification of participants keyed to their project(s) of interest. Consequently, a custom-made summary can be prepared for the benefit of each, reporting comprehensivel in individual areas of interest. The availability of such outputs allows each participant to take advantage of others' knowledge of equipments and their operational capabilities. A contribution to the planning, implementation, or application of R&D projects can best be appreciated if full knowledge of the context (of needs being addressed or ignored, and projects being funded or deferred) is made available to relate to the individual's knowledge of equipments and operational capabilities being affected.

C. DISCUSSION

From the preceding application it would appear that the subject has been properly considered in terms of the development of an hypothesis and an approach to testing a methodology. At this point we should turn to a recognition of some of the "real world" problems of application and outline future development requirements. Once this is done we will have a better picture of the status of the effort.

1. PROBLEMS OF APPROACH

a. A common first step in the solution of many problems is to treat them as static. For example, at this time we look at the current data base as a snapshot of needs, capabilities, etc., and call

it a baseline. In fact we have a changing baseline. Needs change as a result of both solutions to past problems and introductions of new ones. If nothing else the needs respond to changing threats over which we have no control.

The needs statements file must be updated as new documents and new needs evolve. As more experience is gained through sample runs and actual user experience, errors in characterization as well as incompletely characterized needs must be constantly corrected. For this approach to provide a viable baseline a committment is necessary to expend resources on the maintenance of a current verified data file.

b. Another element in problem solving is the establishment of assumptions. One assumption in the early stages of development of the data bank was that the sub-operational capabilities (SOC) contained in OPNAVINST 3501.2 would provide a meaningful interface for relating needs to hardware systems. However, there are limitations in using these SOC's because of inconsistencies, omissions, and inadequacies. A system tied to SOC's is bound to inherit some of the same problems. In particular, the analysts frequently find that some needs cannot be assigned "obvious" SOC's because the SOC level of detail is too precise or too general, or because no SOC addresses the subject. Therefore, some needs are characterized as "no applicable SOC," and will not appear in a SOC extraction list unless the SOC Directive is modified as suggested in B3(a) above.

In the meantime to alleviate this problem, the analyst is forced to "interpret" either the need or the SOC (or both) in order to find a match. The "interpretation" is an unacceptable condition because it can and does vary over broad limits among different interpreters as well as for the same interpreter over a period of time.

c. Another assumption problem carries over into assessment area of NSD users. The NSD developer assumes that the new approach to planning will be enthusiastically accepted by all because of its "obvious benefits". Unfortunately there is a problem of communication, which affects both the developer and the potential user. First, the developer must be aware of the need to sell his approach. What's obvious to him may not be obvious to the user or the language he speaks may be foreign to the user. Second, perhaps a more subtle problem relates to "What's in it for me?" A potential user who has successfully cornered his share of R&D dollars year in and year out is not going to be enthusiastic about a system which might threaten his "rice bowl". He does not want to hear of any change. These problems need both airing, as this paper is intended to provide, and top management attention for the best interests of the Navy.

d. For potential participants there is a serious consideration; they must be convinced that it's worthwhile. Each individual feels that his workload is increasing and that time demands exceed the time available. Yet, in the introduction of a system such as this, there is a need for a number of people to devote some of their time to review the basic data and to make the necessary judgements and evaluations. To obtain the necessary support, after the participant is "sold" on the value of the approach, the material provided for the review must be prescreened or filtered so as to minimize the demand on his time.

This latter point is especially significant when one considers the magnitude of the existing data bank, e.g., there are presently over 1600 needs, derived from approximately 300 source documents, related to more than 780 SOC's, and associated with one or more types of ships ranging from submarines to amphibious craft to aircraft carriers.

e. In addition, many needs are directly related to various weapons, sensors, and other systems, which have multiple functions and applications. The preciseness of the definition of needs varies significantly between source documents, and with the large number of sources involved there are bound to be duplications of needs. Furthermore, in many cases there is a variation in the breadth of the needs statements. If needs are grouped from various sources, in addition to duplication, there is also a problem in the hierarchy of needs, such as that shown below in a way which indicates the subordinate relationships:

A. Improved surface ship ASW capability

1. Improved Detection and Classification

a. Passive Towed Arrays
b. Escort Passive Capability
c. Active Sonars

(1) Active Sonar Classification
(2) etc

Each item listed is included in the current data base as a separate need. With such a tiering of needs, the basis for establishing priorities, for example, becomes difficult to define. Similar sets or families of needs should be identified, and a consistent prioritization process should be established for treating hierarchies.

f. In some organizations, there is little incentive to get involved in R&D planning. In the ship design community which should benefit most from this approach, R&D planning competes for time with active ship design programs. In some areas a person-to-person relationship between individuals in the organization and individual NAVSEA program sponsors is the only real link in the R&D planning process. An organization such as NAVSEC, for example, is neither staffed nor organized to effectively

support R&D planning as a corporate function. In a laboratory, on the other hand, where R&D is of prime importance, there are not enough qualified individuals to review operational needs and projects and to judge their applicability to newly developing ships on as comprehensive a basis as is necessary for program decisions.

2. FUTURE DEVELOPMENT

As resources become available for the NSD program the development of the approach and its applications are expected to include overcoming the foregoing problems. Space does not permit discussions of solutions to these problems which are being attacked as part of the NSD program. None are considered insurmountable but the tentative solutions must be examined to see if they are viable and cost-effective. Applying the principles for which the data base exists is first priority, even if not done as neatly as desired because of existing problems. Decision processes related to ship development which are being implemented annually need help. We must communicate the value of our approach to management and convince them to take advantage of it as soon as possible.

There are two primary contributions of this new look at old data. The first is centralizing scattered decision making information and directly associating it with the structured operational capabilities[7] expected from current and future shipborne systems. The second is the capability to produce custom made outputs of the data for a wide variety of users in a short time.

The proposal of new Advanced Systems Concepts to be developed through R&D is invited by reference 2 "for entry into the Navy development and acquisition selection process". A review of the data base will identify needs which address critical inadequate operational capabilities that are not being addressed by developments in progress. In turn, this provides the opportunity to bring these shortfalls to the attention of OPNAV. The current procedure[12] for needs identification is a distributed function which is centrally coordinated only to the degree of selecting from proffered candidates. The new look provides a basis for comprehensively identifying the weaker capabilities or short falls from each mission in order to induce a search for proposals to relieve the situation.

These advanced system concepts can be examined to identify technical deficiencies which are expected to prevent or degrade an effective system development. These sub-needs can be addressed in the exploratory development category of R&D while awaiting acceptance of the advanced development system accompanied by the resources necessary for acquisition.

Independent of these advanced system thrusts, the observation of unfulfilled needs which limit effectiveness of current shipborne systems also leads to critical exploratory development efforts as well as redirection of current advanced development efforts. The continual accumulation of these opportunities for improvement is an on-going process identified with the responsibilities of R&D program managers. The new look provides a better record for top management's view of such candidates for funding and provides a systematic association of candidates with the mission applications intended both to fill gaps and to compete with less effective options.

The cost benefit associated with the identification of direction for new developments must include the identification of time constraints to accommodate the formulation of new ships or modernization of current ships. The current process of ship development takes advantage of R&D progress only if it has occurred by the time ship concept design commences. The new look at when satisfaction of needs would be most appropriate will contribute to cost benefit analyses. These analyses will affect both direction of emphasis in resource allocation and degree of advance of individual developments.

The recent advent of force sponsor documents[16] has improved the recording of expectations from R&D associated with new ship developments. In addition each project usually has some ship type application mentioned in its description. The new look acknowledges these data and enhances their value by organizing the data by ship type and by associating milestone plans with the sequence of activities necessary for a development to become incorporated into a ship system.

This new look is partly the result of, but more importantly is attuned to the new management thrusts being implemented as required by directives (MENS,[19] ZERO-BASE BUDGETING,[20] MISSION BUDGETING,[21] TECHNICAL STRATEGIES[22]) intended to improve the knowledge of relevance to mission. Packaging data from the RBL by mission area (sets of SOC) provides the starting point for evaluations: (a) demanded by ZBB in the form of decision packages, (b) suggested for organization by the mission budgeting report, and (c) selected as the structure for technical strategies.

3. STATUS OF EFFORT

Referring to the original hypothesis in the introduction concerning the ship development process, for each portion of A - L there have been some efforts aimed at understanding and analyzing the sub-processes involved. There are many descriptions of parts of the overall ship development process and there are many involved organizational units associated by charters, instructions, or practices. No attempt has been made to consider all of these units, but as a major influence on the process is recognized, it is investigated.

A visit to a cognizant code and a copy of a pertinent directive or other document introduces a new participant to the system and identifies the "mechanism" of his involvement. Each new participant is considered a contributor of input and/or a receiver of output. His participation is translated into a language compatible with the languages of other participants with whom he may not have direct contact. The quality and timing of input/output must be examined to recognize opportunities for improvement.

In addition to the status of the NBL data discussed in B-2 above, Display 8 lists for each element A - L of the ship acquisition hypothesis; (a) the NAVSEA "trustee", and (b) the "mechanisms" which have been reviewed for their potential association with the NBL data bases, the status of which are discussed below:

a. HYPOTHESIS ELEMENTS - A B and C
MECHANISMS - SECAS and APPROVED CHARACTERISTICS

SECAS[17] represents the accepted data base of subsystem options which have been selected for active fleet units. The configurations of these ships are known but their relative performance for the same SOC need to be examined. We are acquiring the pertinent portions of SECAS in a form compatible with the objective of NSD, that is to establish a baseline of inventory equipments representing future subsystem options if no R&D projects were to be funded.

Another avenue to establishing the "starting point" for subsequent sub-processes is to assimilate the information available in "approved characteristics"[26] to correlate installed subsystems with the statements which suggest why they were selected.

b. HYPOTHESIS ELEMENTS - D and E
MECHANISMS - Plans and Letters

The operational needs already entered in the NBL represent raw data from primarily OPNAV documents. Supplementing these with other needs, which are known by participants in the ship development process, and from privately held official sources (i.e. existing in a set of distributed files, rather than a centrallized file), is a goal in the next step of the program. Associated with this data collection are the current efforts, (1) to establish a hierarchical process for relating associated needs, (2) to combine similar statements from more than one source, and (3) to devise an importance rating method to accommodate (1) & (2).

c. HYPOTHESIS ELEMENTS - F, G, and H
MECHANISMS - POM, TLS, and PADS

The utility of the NBL in the decision-making processes which determine (1) the funding and personnel distribution[13] among items and functions under NAVSEA management, and (2) the selection of subsystem

options (TLS,[15] PADS[27]) in the design of ships will be determined by the progress made in the NSD effort and by the awareness and appreciation of how it can be used. The current NBL content of R&D project data for shipborne subsystems is complete (except for NAVELEX exploratory development) through FY 77 funded projects and POM 80 proposed projects. A deficiency which needs early attention in improving this file is the lack of data depicting the next lower level units of R&D effort, i.e., subproject or task level. This data is needed to distinguish more clearly the multi-contributions that projects actually address.

d. HYPOTHESIS ELEMENTS - I and J
MECHANISMS - STEP and ASU

The replacement policy which has been addressed in the electronics field by Ship Type Electronics Plan (STEP)[28] is being examined to realize the implications of an earlier mode of applying similar policy, and of extending the concept to fields other than electronics.

The route of establishing Approval for Service Use (ASU[29]) is also being examined to take advantage of those efforts which occur independently of ship development, but which could contribute to the process in the pre-acquisition phase.

e. HYPOTHESIS ELEMENTS - K and L
MECHANISMS - TLR, MEL, TLS and PMI

The current processes (TLR[3]/MEL/TLS[15]) of development have much to gain from the NSD effort and are prime targets for improvement. Even with the relatively primitive RBL content existing today, a draft TLR (list of SOC) can be used to generate (1) a first iteration of (advanced) MEL options for the TLS, and (2) a mission deficiency (list of needs) observation for a second iteration TLR. The addition of SECAS data to the baseline will improve the process.

The "Proposed Military Improvement" (PMI[24]) concept as part of the Fleet Modernization Program calls for early identification of potential system installation plans. The NBL milestone data implement and extend this concept to earlier but less definite plans.

Existing data bases related to Hypothesis elements A thru L are being brought together through the commonality provided by structures such as the "Ship Work Breakdown Structure"[14] (SWBS) for ship subsystems and the Mission/Capability (SOC) structure for "Top Level Requirements" for new ships.

Data sources include people, guidance documents, recurring reports, and existing computerized data bases. These data are accumulated over time, annotated with useful structures, and organized in planned work-sheet displays for the purpose of analyses.

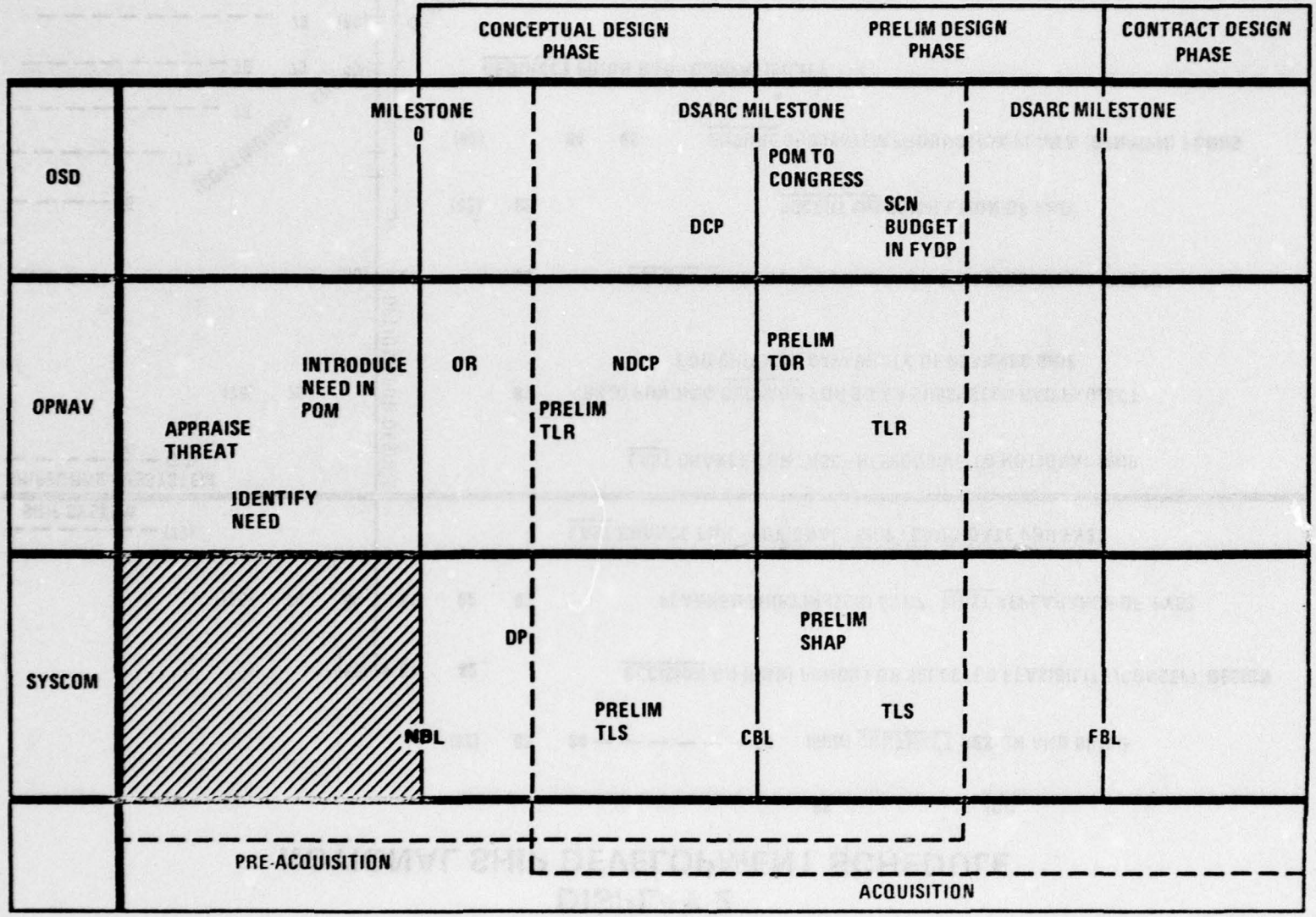
Customized output structured for a specific analyst provides a unique input for planning. Decisions can be based on the usual information available at the time, but the process may be enhanced by the comprehensive, orderly, presentation of one (or more) element(s) of the Hypothesis.

The potential spinoffs of the Notional Ship Development Program are unlimited. R&D funds and efforts can be managed more efficiently and each effort can be justified by its application to specific operational needs. The business of acquiring ships for the Fleet provides the only reason for the existence of NAVSEA. The ships acquired should be those which meet the operational needs of the Fleet in the most timely and effective manner. The NSD program can aid in this goal and should be supported at all levels.

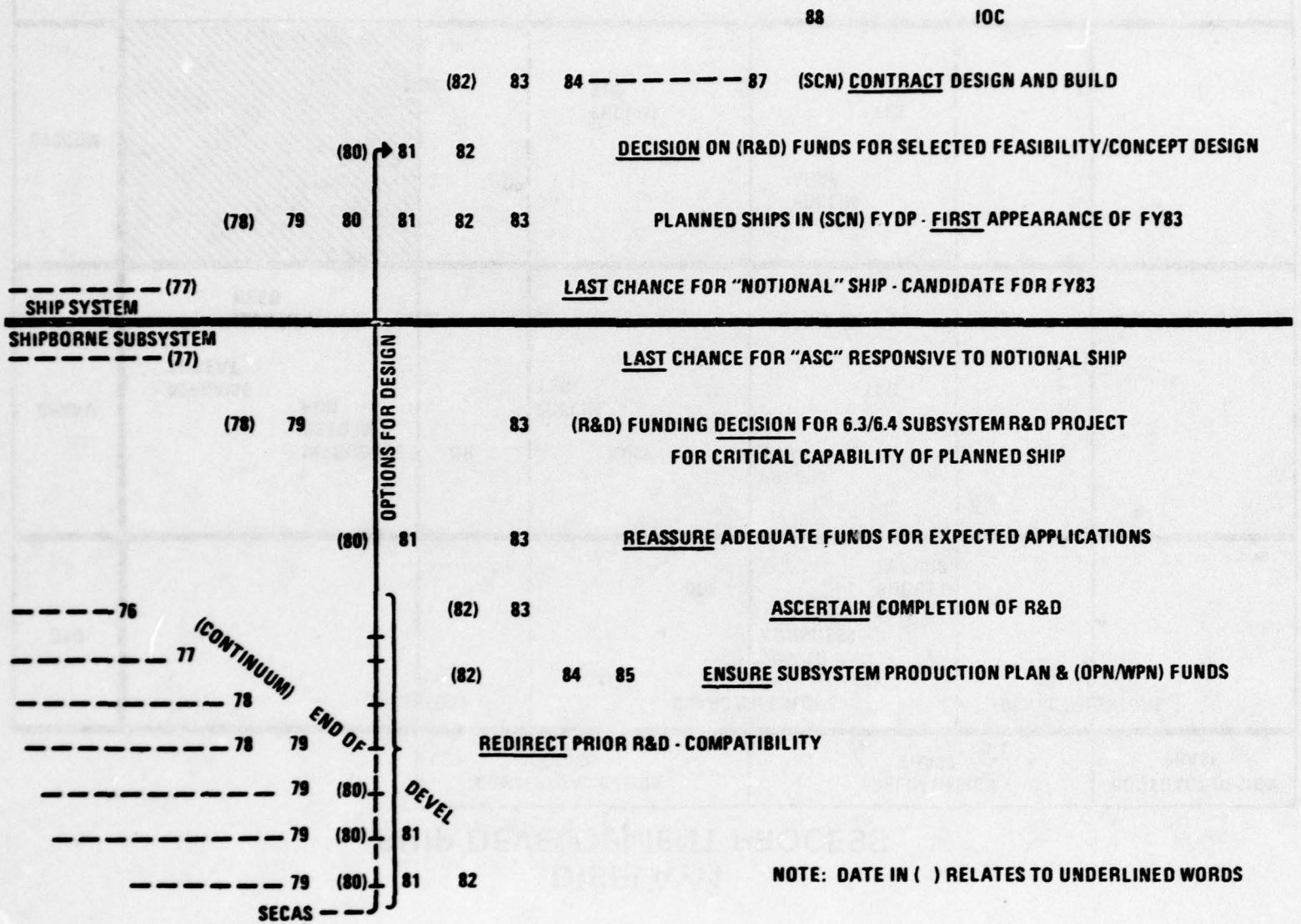
Superscript (Reference #)	REFERENCES
1	Ship Development Process - NAVSEAINST 9060.4
2	Operational Requirement/Development Proposal/Scientific and Technology Objective - OPNAVINST 5000.42
3	Top Level Requirements - OPNAVINST 9010.30
4	Advanced Ship Systems Development Planning Manual
5	Course and Speed - NAVSHIPS Management by Objectives Document, 1970
6	Conceptual Baseline, Functional Baseline - NAVMATINST 4130.1
7	Sub-Operational Capability - OPNAVINST 3501.2
8	Naval Warfare Information Publication 11-20
9	Force Status Report - OPNAVINST 3501.5
10	Required Operational Capability - OPNAVINST 3501.3
11	Operational Test and Evaluation Force - OPNAVINST 5440.47
12	Advanced Systems Concepts - NAVMATINST 3910.10
13	Program Objectives Memorandum - NAVSEAINST 7100.4
14	Ship Work Breakdown Structure - NAVSEA 0900-LP-039-9010
15	Top Level Specifications - NAVSEA 9060.1
16	Chief of Naval Operations (OP-03) Surface Warfare Plan
17	Ship Equipment Configuration Accounting System (NAVSEA 04)
18	Functional Subprogram Groups - NAVSEA 03 Memo of October 1975
19	Mission Element Need Statement - DOD INST 5000.2
20	Zero - Base Budgeting - OMB Bulletin 77-9

Supercript (Reference #)	REFERENCES (Cont'd)
21	Mission Budgeting - GAO Report
22	Technical Strategies - ASN (R&D) Memo
23	Laboratory Product Lines - Director of Navy Labs
24	Proposed Military Improvements - NAVSEAINST 4720.3
25	DSARC Milestones - DOD INST 5000.1
26	Approved Ship Characteristics - OPNAVINST 9010.XXX
27	Performace Analysis Data Sheets -
28	Ship Type Electronic Plan - OPNAVINST 9670.2
29	Approval For Service Use - NAVSEAINST 4720.1

DISPLAY 1
SHIP DEVELOPMENT PROCESS



DISPLAY 2
NOTIONAL SHIP DEVELOPMENT SCHEDULE



DISPLAY 3

SOURCE OF NEEDS

a	JRDOD JAN 75 & 76
b	MISSION AREA SUMMARY, FEB 75 & 76
c	SWP, AUG 75 SURF WARF PLAN
d	ATTACK SUB WARFARE PLAN, FEB 75
e	ASW MASTER PLAN, JUNE 74
f	LRO/MRO/GOR 1973 & EARLIER
g	SCIENCE & TECHNOLOGY OBJECTIVES 1975
h	ADO's/SOR's/OR's THRU JUN 77
i	LR R&D PLANNING 1975
j	PROJECT 2000, JUNE 74
k	RED/GREEN STUDY, DEC 74
l	WEAPONS TABLES MAY 74
m	SEA 0313 FILE 1975
n	NAVSEA R&D NPPG FY79-83 NOV 76

DISPLAY 4

NAVAL WARFARE MISSION AREAS

1. Guidelines. All fleet units as well as combat unit components of the Naval Reserve are designed or orgainzed to perform one or more of the following Naval Warfare Mission Areas. These mission areas are divided into two categories: (1) Fundamental Mission Areas and (2) Supporting Mission Areas.

2. Fundamental Mission Areas:

a. Anti-air Warfare (AAW)
b. Antisubmarine Warfare (ASW)
c. Antisurface Ship Warfare (ASU)
d. Strike Warfare (STW)
e. Amphibious Warfare (AMW)
f. Mine WArfare (MIW)
g. Special Warfare (SPW)

3. Supporting Mission Areas:

a. Mobility (MOB)
b. Command and Control and Communications (CCC)
c. Intelligence (INT)
d. Electronic Warfare (ELW)
e. Logistics (LOG)
f. Fleet Support Operations (FSO)
g. Construction (CON)
h. Noncombat Operations (NCO)

4. Operational Capability. A subdivision of a mission area which more specifically delineates appropriate operational functions. The selections have been made, as far as possible, independent of a platform type.

EXAMPLE: ASW 9 - Engage submarines with antisubmarine armament.

5. SUB-OPER. CAPAB (SOC)

EXAMPLE: ASW 9.6 - Attack with torpedoes.

DISPLAY 5

LIST OF FUNCTIONS

NO.	SWBS	TITLE
1	410	CONDUCT OWN UNIT COMMAND AND CONTROL TASKS AND FUNCTIONS.
2	410	CONTROL AND/OR COORDINATE MOVEMENTS OF OTHER UNITS.
3	410	CONTROL AND/OR COORDINATE AIR OPERATIONS.
4	410	PROVIDE COMMAND/CONTROL FACILITIES FOR EMBARKED COMMANDER.
5	410	CONTROL CARRIER-AIR RELATED OPERATIONS.
6	410	COLLECT INTELLIGENCE AND INFORMATION.
7	410	PROCESS/EVALUATE INTELLIGENCE AND INFORMATION.
8	410	MAINTAIN AND DISSEMINATE INTELLIGENCE AND INFORMATION.
9	420	PERFORM OWN UNIT NAVIGATION FUNCTIONS.
10	420	PROVIDE NAVIGATION INFORMATION/INSTRUCTIONS TO OTHER UNITS.
11	440	COMMUNICATE WITH OTHER UNITS AND SHORE FACILITIES.
12	440	RELAY COMMUNICATIONS BETWEEN OTHER UNITS AND/OR SHORE FACILITIES.
13	450	DETECT AND/OR CLASSIFY AIRBORNE TARGETS.
14	450	DETECT AND/OR CLASSIFY SURFACE TARGETS.
15	460	DETECT AND/OR CLASSIFY SUBMARINES.
16	470	CONDUCT MINESWEEPING, MINEHUNTING, AND MINE NEUTRALIZATION OPS.
17	470	PERFORM DECEPTION, EVASION, AND/OR AVOIDANCE OPERATIONS.
18	470	CONDUCT ELECTRONIC WARFARE OPERATIONS.
19	470	CONDUCT ACOUSTIC WARFARE OPERATIONS.
20	480	LOCALIZE AND/OR TRACK SURFACE TARGETS.
21	480	LOCALIZE AND/OR TRACK SUBMARINES.
22	480	LOCALIZE AND/OR TRACK AIRBORNE TARGETS.
⋮	⋮	
74	ETC.	

DISPLAY 6

2-DIGIT
SELECTIONS FROM
SHIP WORK BREAKDOWN STRUCTURE

Number	Title
05	(TOTAL) SHIP SYSTEM PERFORMANCE
07	GENERAL REQUIREMENTS (PROTECTION)
10	HULL STRUCTURE
20	PROPULSION PLANT
30	ELECTRIC PLANT
41	COMMAND AND CONTROL SYSTEMS
42	NAVIGATION SYSTEMS
43	INTERIOR COMMUNICATIONS
44	EXTERIOR COMMUNICATIONS
45	SURVEILLANCE SYSTEMS (SURFACE)
46	SURVEILLANCE SYSTEMS (UNDERSEA)
47	COUNTERMEASURES
48	FIRE CONTROL SYSTEMS
50	AUXILIARY SYSTEMS
59	SPECIAL PURPOSE SYSTEMS (OCEAN & HUMAN SUPPORT)
71	GUNS
72	MISSILES AND ROCKETS
73	MINES
75	TORPEDOES
79	SPECIAL PURPOSE SYSTEMS (WEAPON)
80	INTEGRATION/ENGINEERING

DISPLAY 7

FUNCTION/PERFORMANCE AREAS

1	VEHICLE, GENERAL
2	SHIPBORNE SENSORS
3	DEPLOYED SENSORS
4	SHIPBORNE WEAPONS
5	DEPLOYED WEAPONS
6	SHIP-BASED AIRCRAFT
7	MEDICAL/PERSONNEL
8	LOGISTICS
11	VULNERABILITY
12	READINESS
13	COMPONENT TECHNOLOGY
14	PLANNING & MANGEMENT
21	OFFENSIVE CAPABILITY
22	DEFENSIVE CAPABILITY
23	ELECTONIC WARFARE
24	ACOUSTIC WARFARE
25	COMBAT SUPPORT
26	NONCOMBAT OPERATIONS
27	AMPHIBIOUS OPERATIONS

DISPLAY 8

CURRENT SUB-PROCESSES

	NAVSEA TRUSTEE	MECHANISM
A. INSTALLED SHIPBORNE EQUIPMENT/SYSTEMS, which	04	SECAS
B. PROVIDE OPERATIONAL CAPABILITIES, at	--	APPROV. CHARAC.
C. CURRENT PERFORMANCE LEVELS, have	06	--
D. OBSERVED DEFICIENCIES, or	04/06	PLANS/LTRS
E. POTENTIAL INADEQUACIES, which require	03	--
F. RESOURCE ALLOCATION, or	00	POM/ZBB
G. ENGINEERING ADAPTATION, or	06	PADS
H. DEVELOPMENT, to	03/06	R&D
I. REPLACE, or	04	STEP
J. IMPROVE CURRENT OPTIONS OF SUBSYSTEMS, dor	03/06	ASU
K. NEW CONSTRUCTION, or	06/PMS	TLR/MEL/TLS
L. MODERNIZATION OF NAVY SHIPS.	04/06	PMI