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AN OVERVIEW APPROACH TO LOGISTIC SUPPORT ANALYSIS--MAJOR U.S. NAVY AIRCRAFT PROGRAMS

STUDY PROJECT REPORT
PMC 75-2

Robert R. Humphrey
Lockheed California Company

AN OVERVIEW APPROACH TO LOGISTIC SUPPORT ANALYSIS-U.S. NAVY MAJOR AIRCRAFT PROGRAMS.

Study Project Report,

Individual Study Program

Defense Systems Management School

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Robert R. Humphrey

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Study Project Advisor
LTC H. Behrens, USA

This study project report represents the views, conclusions and recommendations of the author and does not necessarily reflect the official opinion of the Defense Systems Management School or the Department of Defense.

EXECUTIVE SUMMARY

Purpose and Focus of Study Project

There has been considerable misunderstanding and discussion of the basic issue and intent of MIL-STD-1388-1 and -2, Logistic Support Analysis, relative to application to Naval Air Systems Command major aircraft weapon system programs. The purpose and focus of this study project is to identify the basic issue of the LSA process as the interface and integration of the system engineering and LSA processes in pursuit of a common goal--definition of system requirements and progressive development of design with the objective of fielding a weapon system optimized to provide the desired performance capability, availability, supportability, and economic efficiency in the planned operational environment.

Study Project Report Orientation

Based on analysis of MIL-STD-1388-1 and -2 and associated specifications and standards, plus interviews with NAVAIRSYSCOM personnel responsible for final preparation and issuance of MIL-STD-1388, the system engineering and LSA processes are oriented in discussion to the natural evolutionary process from determination of system requirements to meet a specific military need, to establishment of final detail design and configuration maintenance. This is accomplished through assumption of a hypothetical weapon system program involving competitive prototype aircraft development, and discussion of this evolutionary process in terms of the acquisition life cycle (Conceptual, Validation, Full Scale Development, and Production/Deployment Phases). Finally, conclusions and recommendations are provided based on the writer's experience as a contractor representative involved with

Integrated Logistics Support since the year 1961.

Conclusions, Recommendations and Implications

The LSA and system engineering processes are highly iterative throughout the acquisition life cycle as system, subsystem, weapon replaceable assembly, and major repairable component functional/physical characteristics are definitized and detail design is established. The LSA process provides standard methodology for integrating logistic support requirements into aircraft design, and a common data base of design and logistic support characteristics to allow functional support element managers to develop complementary support assets for operational support.

Recommendations include (1) co-location of logistic and operations research engineers within the engineering project for the specific weapon system program, (2) early establishment of the LSA process in the Conceptual Phase with depth of analysis in consonance with the system engineering process (contributing to the progressive development of aircraft design specifications and baselines), and in support of major program milestones, (3) delay of spare and repair parts provisioning until subsystem design matures and significant maintenance usage data is accumulated to allow decisions of range and depth of recuirements to reflect fleet experience, and (4) successful implementation of the LSA process by first translating the standards contained in MIL-STD-1388 into an update of AR-30A, Integrated Logistic Support Program Requirements, and finally, preparation of MIL-HDBK-240 guidelines for LSA performance.

The LSA process has the potential to ensure incorporation of logistic support and operational economic and efficiency characteristics into aircraft design.

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R. E. Mims
Division Head, Advanced Concepts Projects
Naval Weapons Engineering Support Activity
Naval Air Systems Command

A. Gossman
Supervisor, Advanced Concepts Projects
Naval Weapons Engineering Support Activity
Naval Air Systems Command

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Potomac Research, Inc.

S. P. Light
Student, Defense Systems Management School

NOTE: The contributions of the above named individuals are not be be misinterpreted as approval of this study project report, since only the views and opinions of the writer are represented herein.

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INTRODUCTION

Purpose of the Study Project

Integrated Logistic Support (ILS) plans and policy personnel at the Naval Air Systems Command (NAVAIRSYSCOM) are formulating procedures for implementation of the Logistic Support Analysis (LSA) methodology defined in Military Standard (MIL-STD) 1388-1, dated 15 October 1973.[9] This effort is a refinement of previous applications to aircraft weapon systems currently under development. It is the purpose of this report to present a condensation of the intent of MIL-STD-1388-1, and to incorporate observations for a natural integration of the LSA process with the evolutionary system engineering process. Department of Defense Directive 5000.1, Acquisition of Major Defense Systems, states:

> Logistic support shall also be considered as a principal design parameter with the magnitude, scope and level of effort in keeping with the program phase. Early development effort will consider only those parameters that are truly necessary to basic defense system design, e.g., those logistic problems that have significant impact on system readiness, capability or cost. Premature introduction of detailed operational support considerations is to be avoided.[3:4]

MIL-STD-499A, Engineering Management, dated 1 May 1974 describes the relationship of Integrated Logistic Support with system engineering (Part III of the System Engineering Management Plan) as follows:

> ILS planning impacts upon and in turn is impacted by the engineering activities throughout a system life cycle. Initially, support descriptors in the form of criteria and constraints are furnished with the top level system operational needs. These descriptors will include such items as basing concepts, personnel, or training constraints, repair level constraints, and similar support considerations. ILS descriptors should be quantified whenever

possible and then be continually and progressively refined and expanded with the evolution of the design. System engineering, in its evolution of functional and detail design requirements, has as its goal the achievement of proper balance among operational, economic, and logistic factors. This balancing and integrating function is an essential part of the system/cost effectiveness trade-offs and studies. Normally, the lower ILS descriptors will influence and be influenced by their relationship to costs of ownership and Reliability and Maintainability (R&M) parameters. Thus, the integration of ILS concepts and planning considerations into the system engineering process is a continual and iterative activity, with the output being the optimal balance between performance and support considerations and optimal trade-offs among costs of ownership, schedule, and system effectiveness.[8:8]

Specific Goals of the Project

The goals of this project are summarized as follows:

1. To reveal the distinct benefits of the LSA process over the previous Maintenance Engineering Analysis programs.
2. To reveal the natural and necessary interface and integration of the LSA process with the systems engineering process toward the achievement of common objectives.
3. To provide recommendations based on the writer's ILS experience.
4. To provide an objective understanding of the LSA process for application to future air vehicle weapon system programs.

Definitions

1. Critical Design Review (CDR): This review shall be conducted for each CI when detail design is essentially complete. The purpose of this review will be to (1) determine that the detail design of the CI under review satisfies the performance and engineering specialty requirements of the CI development specifications, (2) establish the detail design compatibility among the CI and other items of equipment, facilities, computer programs and personnel, (3) assess producibility and CI risk areas (on a technical, cost, and schedule basis), and (4) review the preliminary product specifications.[8:14]

2. Development Specification: ....state the requirements for the design or engineering development of a product during the development period. Each

development specification shall be in sufficient detail to describe effectively the performance characteristics that each configuration item is to achieve when a developed item is to evolve in a detail design for production.[7:3]

3. Logistic Support Analysis (LSA): A process by which the logistic support necessary for a new system/equipment is identified. It includes the determination and establishment of logistic support design constraints, consideration of those constraints in the design of the "hardware" portion of the system, and analysis of the design to validate the logistic support feasibility of the design and to identify and document the logistic support resources which must be provided, as a part of the system/equipment, to the operating and support forces. Analytical techniques used to determine limited aspects of logistic support requirements are a part of the overall LSA process....[4:4]

4. Logistic Support Analysis Record (LSAR): The final documentation of the logistic support analysis, recorded in deliverable form, that is the basic source of data related to the maintenance and logistic support for a specific item.[4:4]

5. Preliminary Design Review (PDR): This review will be conducted for each CI or aggregate of CI's (Configuration Items) to (1) evaluate the progress, technical adequacy, and risk resolution (on a technical, cost and schedule basis) of the selected design approach, (2) determine its compatibility with performance and engineering specialty requirements of the CI development specification, and (3) establish the existance and compatibility of the physical and functional interfaces among the CI and other items of equipment facilities, computer programs, and personnel.[8:14]

6. Product Specifications:....are applicable to any item below the system level, and may be oriented toward procurement of a product through specification of primarily function (performance) requirements or primarily fabrication (detailed design) requirements.[7:5]

7. System Design Review (SDR): This review shall be conducted to evaluate the optimization, correlation, completeness, and the risks associated with the allocated technical requirements. Also included is a summary review of the system engineering process which produced the allocated technical requirements and of the engineering planning for the next phase of effort. This review shall be conducted when the system definition effort has proceeded to the point where system characteristics are defined and the allocated configuration identification has been established. This review will be in sufficient detail to ensure a technical understanding among all participants on (1) the updated or completed system or system segment specification (2)....[8:13]

8. System Engineering Process: A logical sequence of activities and decisions transforming an operational need into a description of system performance parameters and a preferred system configuration.[8:3]

9. System Requirements Reviews (SRR): These reviews shall be conducted to ascertain progress in defining system technical requirements and implementing other engineering management activity. The number of such reviews will be determined by the procuring activity.[8:13]

10. System Specification:....states the technical and mission requirements for a system as an entity, allocates requirements to functional areas, and defines the interfaces between or among functional areas.[7:3]

Scope of the Project

This report encompasses the LSA process in terms of "what" is required throughout the acquisition life cycle. As such, the primary thrust is a portrayal of a joint systems engineering/logistic support analysis process. An overview is provided, thus eliminating the tendency to become engrossed in detail which overshadows the simplicity of a natural, evolutionary progression from requirement determination to fielding an effective, efficient and economical weapon system.

Limitations of the Project

Since this report provides an overview of the LSA process, no attempt is made to deal with such important matters as "how" LSA should be implemented. MIL-STD-1388-1[5] and 1388-2[6] (Logistic Support Analysis Data Element Definitions) are Tri-Service documents which allow each Service flexibility in detail application of requirements. Further, LSA includes seven of the nine ILS elements identified in DoD Directive 4100.35, Integrated Logistics Support.[2:2] Although LSA is the key process inachieving an integrated logistic support program, separate functional disciplines exist for planning and acquiring physical support assets for the other logistic elements that comprise a total support system, (not separately discussed herein). All report considerations are based on application of LSA to NAVAIRSYSCOM major aircraft weapon system programs.

Organization of the Report

As noted in the Table of Contents, an Introduction is provided in Section I, and a brief background of early efforts to achieve "Integrated Logistic Support" is provided in Section II. Section III then discusses the Present Situation and Current Philosophy of Integrated Logistic Support in view of the LSA process. Sections IV through VII discuss the evolutionary aspects of the LSA/system engineering effort as applicable in each phase of the weapon system acquisition cycle. A primary premise of Sections IV through VII is that discussion is based on a hypothetical program which includes full scale prototype aircraft in the Validation Phase. Finally, Section VIII covers Conclusions, Recommendations and Implications.

SECTION II

BACKGROUND

MEA Programs - AR-30

Prior to the advent of LSA, integration of support element requirements for NAVAIRSYSCOM aircraft programs was achieved through the Maintenance Engineering Analysis (MEA) program, according to the requirements of NAVAIRSYSCOM Aeronautical Requirement (AR)-30 specification. This specification was tailored in application to each individual program on the basis of weapon system complexity. The MEA program was excellent in the discipline applied to achieve integration of all functional support element requirements, through consistent use of common maintenance plans and analysis data for the weapon system, subsystems, equipments, and components. Logistic specialists in areas such as support equipment, spares, technical data, training, and personnel used identically documented maintenance data to develop and acquire totally complimentary support assets for operational support. The result was the proper mix of numbers of trained maintenance personnel, the technical manuals required to perform maintenance, the support equipment to allow effective maintenance of specific tasks, and assurance of the appropriate provisioned spare and repair parts to return a component to ready-for-issue (RFI) condition.

The basic shortfall of this approach lies in what was not done, rather than in criticism of the MEA program. Missing was the early integration into weapon system design of the characteristics required to field an aircraft with an optimum mix of performance capability, availability, supportability, and economic efficiency.

SECTION III

PRESENT SITUATION

LSA Implementation Efforts

NAVAIRSYSCOM plans and policy personnel are presently refining the procedures required to translate the standards of MIL-STD-1388-1 and -2, LSA, preparatory to issuing standard specification requirements for specific weapon system programs.[9] The outcome of this effort may logically be a revision of AR-30A[1:3-1-3-15] and, based on this specification requirement, preparation of a handbook for tailored contractor application of the LSA process to individual weapon system programs (Military Handbook-240, not yet issued). The LSA process may be implemented with a manual, automated or combined approach to output documentation. Technical data is expensive, comprising approximately 14% of the acquisition cost of major weapon systems. Accordingly, for major weapon system programs, it appears mandatory that an LSA Record (LSAR) be established in an Electronic Data Processing (EDP) program. MIL-STD-1388-2 provides a standard description of data element inputs to such a data bank. Appendix A of this report depicts sample report outputs that may be machine produced from the LSAR. Maximum use of unmodified machine output reports will minimize the cost of Contract Data Requirements List (CDRL) deliverable items. This will not, however, eliminate the requirement for manually prepared LSA documentation.

The use of a Resident Integrated Logistic Support Detachment (RILSD), stationed at the contractors' facility, provides an excellent opportunity to further reduce the requirement for manually prepared documentation in rigid format (with corresponding adjustment of CDRL requirements). This U. S. Navy team, representing an extension of the office of the Navy Assistant Program Manager-ILS, can, for example, utilize informal contractor documentation to verify LSA trade-off analyses and resulting maintenance concepts. This type of cooperative effort between contractor and Navy members of the Integrated Logistic Support Management Team (ILSMT) can provide an efficient and effective approach to realizing the goals of LSA, while reducing program cost.

Current Philosophy

The primary thrust of the LSA process is to extend "Integrated" Logistic Support to influence design, as well as functional support element requirement (the MEA program) integration.[10,11] Figure 1 depicts the natural evolutionary process of weapon system design and ILS. The key to design integration is the mutual achievement of engineering and logistic goals through a joint team effort that results in progressive embodiment of mutually desired design characteristics in weapon system engineering baselines and specifications.

Accordingly, the LSA process incorporates and replaces the previous MEA program. This may be visualized by reviewing the three basic steps or phases of the LSA process described below:[5:19]

Phase I - General Logistic Support Analysis

1. This phase covers the time period of the Conceptual Phase, Validation Phase, and up to completion of the Preliminary Design Review during Full Scale Development. The LSA process is directed to support synthesis,

trade-off analysis, and design appraisal in the Conceptual Phase, with the objective of integrating viable maintenance and support concepts to the subsystem level (or third level of the Work Breakdown Structure), in the System Specification. ILS requirements for reliability, maintainability, availability and level of repair (in broad terms of a maintenance concept for Organizational, Intermediate and Depot level activity) are quantified to be used as design parameters. The trade-offs are of a subsystem nature to permit selection of types of systems, i.e., UHF versus HF radio, for application to the System Specification and the Functional Baseline. The Navy is primarily responsible for this effort, but prime contractors may expect involvement through conceptual studies.

2. In the Validation Phase of our hypothetical prototype program (envision competetive prototypes in a fly-off during this phase), a similar effort is involved but to greater depth of analysis, although still broad in scope. Prime LSA responsibility normally lies with the contractor, and the results are incorporated in the Development Specification which establishes the weapon system Allocated Baseline.

3. Prior to detail design :. the Full Scale Development (FSD) phase, a Preliminary Design Review (PDR) is conducted by the Navy. The LSA process is involved with ensuring compatability of the weapon system and support system functional requirements in the system engineering process. The PDR is an evaluation of the weapon system functional design as an entity of design performance/physical characteristics and operational support

LSA/SYSTEM ENGINEERING INTERFACE/INTEGRATION

WEAPON SYSTEM ACQUISITION CYCLE

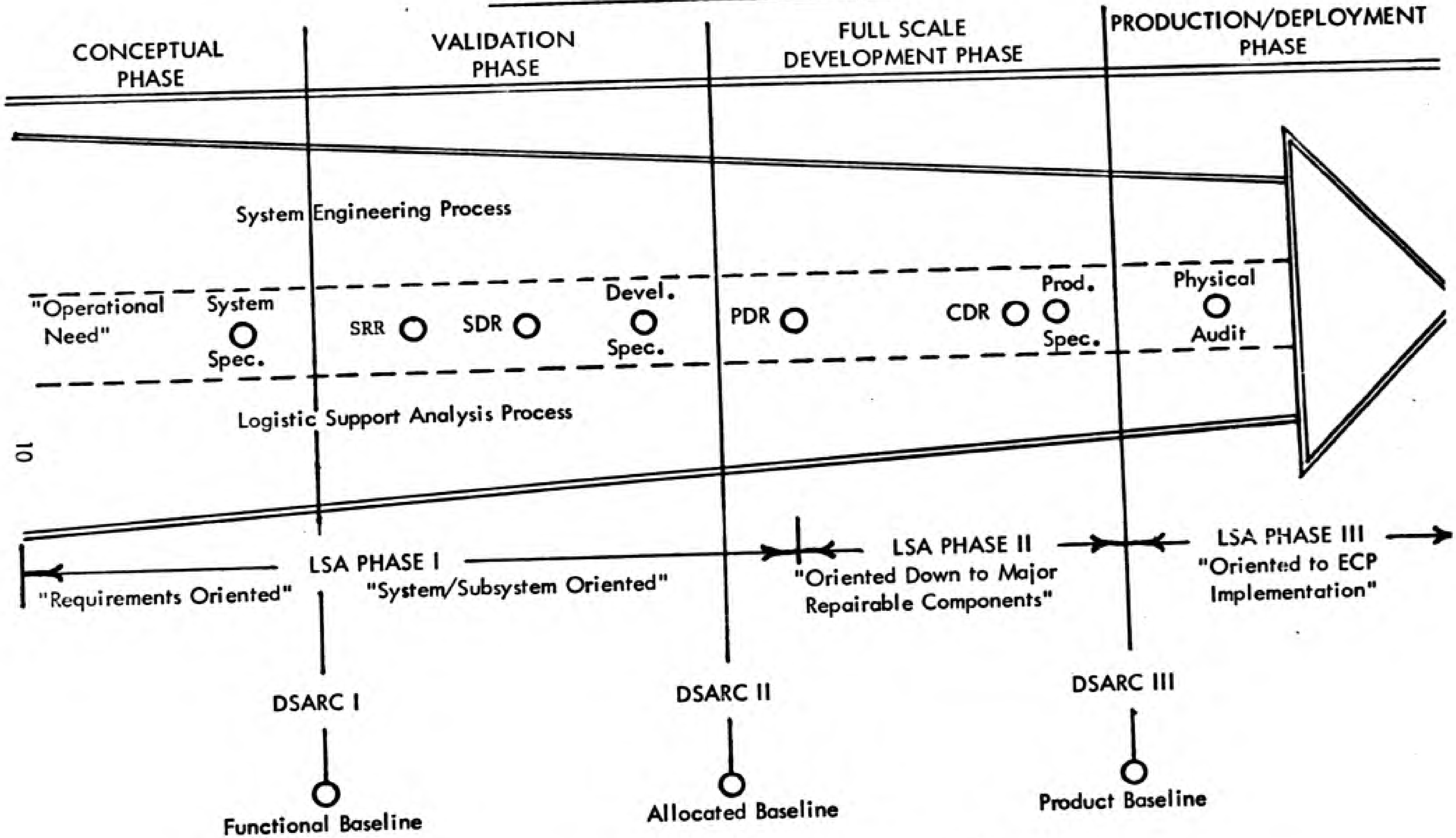

Figure 1, LSA/SYSTEMS ENGINEERING INTERFACE/INTEGRATION characteristics. The results of this effort are documented in the Development Specification and the engineering Allocated Baseline, as modified by the PDR.

Phase II - Detailed Logistic Support Analysis

1. The effort following the PDR in FSD is identical to the old MEA program. Based on the progressive release of detail design, specific and complete maintenance analysis is accomplished for selected systems, subsystems and repairable components. The LSA Record is expanded with inputs from the various support element disciplines for firm support program requirements. Emphasis continues toward impact on design, plus ILS requirements identification. The LSAR is frozen following the CDR at the end of FSD, and the design characteristics representative of the LSAR data base are reflected in the Product Specification and Product Baseline.

Phase III - Revised Logistic Support Analysis

1. During the Production/Operational Phase, changes to the LSAR can only be effected through approved Engineering Change Proposals (ECP's). The initial effort involves incorporation of changes as a result of Development Test III/Operation Test III [Board of Inspection and Survey (BIS) Trials and Operations Test and Evaluation Force (OPTEVFOR) tests].

This overview of the LSA process highlights the mutuality of interest of the system engineering and LSA processes. The goals and objectives are common. The depth of analysis and documentation are common and evolutionary in a common interest to the acquisition phase at hand.

A critical observation at this point is the type of logistic personnel required for

LSA. Logistics organizations have been typically lacking in skilled system engineering and operations research specialists. The LSA requires the use of technical modeling techniques that are complimentary to those used in the system engineering process. Without these skills, logistics personnel cannot effectively communicate and interface with system engineering personnel. If this basic interface fails, so will the intent of the LSA process. Logistic organizations must acquire these disciplines and skilled personnel or suffer the abrogation of LSA responsibilities to the engineering function. This is true because the Navy will see the LSA process effectively implemented--one way or another. The abrogation of responsibility is a poor second choice for the Navy, since it is equivalent to having a Quality Assurance organization reporting to the Chief of Manufacturing Operations (thus negating the authority to function effectively).

SECTION IV

LSA PROCESS - CONCEPTUAL PHASE

Reference; 5:2-19, 10, 11, and 12.

Support Synthesis

The results of the Conceptual LSA process contribute to finalizing the System Specification, through studies of intended use of the weapon system in its role to meet the threat that is dictating the basic requirement. The data required for System Specification inputs includes quantitative parameters for annual operating requirements and availability, reliability, maintainability, mission support profile, and environmental factors, among others. Maintenance and support concept outputs are consistent with the System Specification and completed trade-off studies.

Historical data is accumulated (or data by system similarity), based on the evolving weapon system performance/physical characteristics and functional/performance support requirement characteristics. Data accumulated is synthesized into broad support concepts for weapon system alternatives. This effort is conducted primarily by the Navy and is concerned with such broad considerations as supportability of alternative subsystems to be eventually specified for the weapon system, and application of automated test equipment (used for various weapon systems) versus peculiar support equipment.

Trade-Off Analysis

Using the data gathered for the support synthesis process, trade-offs of alternative weapon system/subsystem configurations are accomplished using reliability, maintainability, availability, life cycle cost (LCC), and support simulation technical modeling techniques. Progressive establishment of a LSAR provides an EDP data bank (supplemented with data for alternative subsystems as appropriate) against which such modeling techniques may be applied. Inputs to the LSAR record come from the traditional disciplines of reliability, maintainability, human engineering and so forth. This trade-off process obviously requires a continual dialogue between logistics and engineering personnel in a mutual effort to optimize a general weapon system configuration. Since we are considering prototype aircraft in the Validation Phase, it may be desirable to establish design to cost (DTC) goals as constraints on contractor development efforts. It would be imperative, therefore, that LCC considerations are firmly imposed upon the DTC determination.

Logistic Design Appraisal

Based on the results of the trade-off analysis, the systems engineering and logistic analysis engineers recommend an optimized weapon system configuration for the System Specification. A Logistic Design Appraisal is accomplished to ensure appropriate logistic considerations are embodied in the System Specification. This configuration is then discussed with "user" (or Fleet) personnel to assure that the proposed support concept parallels the existing Service logistics system. This is known as a System Impact Review, and it includes presentation of subsystem alternatives considered, together with supporting rationale from the trade-off analyses.

Subsequent to this review, physical design, performance and support system factors are established in the LSAR as the data base for launching the Validation

Phase effort. Appropriate ILS data/factors are now finalized in the System Specification and Functional Baseline. It should be noted that the Conceptual Phase analysis is entirely parametric in nature and in equal depth of analysis as that involved in the system engineering process.

Preliminary ILS Requirements Determination

The LSAR, as now established, is used to identify preliminary support requirements in the form of preliminary maintenance, support equipment, supply support and other support element planning concepts for the weapon system and major subsystems. This information provides support system guidance for contractors participating in the Validation Phase. Indeed, a requirement for the DSARC I, Program Initiation Decision, is a Broad ILS Plan which can now be prepared for use in the RFP and Source Selection, DSARC I, and the Validation Phase contracts.

SECTION V

LSA PROCESS - VALIDATION PHASE

Reference; 5:2-21, 10, 11, and 12.

LSA Data Verification

During the Validation Phase, intentional restraint must be exercised to avoid unnecessary expense in detail LSA activity. The prototype program is a minimum cost approach to proving design feasibility, utilizing competing contractors. Normally only one contractor will be selected for FSD, and resources expended by the losing contractor are not recoverable.

Contractors selected and awarded contracts for prototype development and fly-off embark on a course leading to the System Requirements Review. Each contractor responds to the System Specification/Functional Baseline requirements with specific system, subsystem and weapon replaceable assembly (WRA) recommendations. During this period the contractor conducts an iterative effort similar to that performed by the Navy in its Conceptual Phase support synthesis and trade-off analysis activity. Historical data is refined and expanded by each contractor in an effort to home-in on a functional requirement approach to their specific prototype aircraft predicted design. System engineers and logistic analysis engineers join in a review of their planned joint approach to system design and support system definition at the System Requirements Review.

Trade-Off Analysis

Following approval to proceed with system design, each contractor proceeds toward a System Design Review prior to actual fabrication and assembly of the prototype vehicles. The system engineering and logistic support analysis process becomes highly iterative as prototype design progresses, subsystem by subsystem, until a producible design exists. It should be noted that detail design analysis to the component level is not desired. LSA effort remains at the subsystem, WRA, and major repairable item level. During this period the support synthesis and trade-off analyses efforts are continual in an effort to optimize design and support characteristics. The LSAR is expanded and tailored to the specific weapon system configuration. An important activity during this phase is the effort to eliminate risk areas in design and support concepts, and the further definition of specific support problems. Since the basic purpose of a prototype program is to prove design and support concept feasibility, perfection of a final outcome is not anticipated and does not warrant the expenditure of resources that would be required to achieve such a goal.

Level of Repair (LOR) Analysis - Non-Economic

In order to provide a firm maintenance concept for Full Scale Development effort, and, even more importantly to provide a basic input to design, it is desirable to conduct a non-economic LOR analysis prior to the System Design Review. The LOR analysis is focused to determine repair levels based on technical feasibility and the capability existing in the Navy logistic system. Any impact that can be made on design is desirable at this point to avoid redesign during the FSD effort.

System Design Review (SDR)

The SDR is a critical review since it determines the final configuration of the prototype aircraft. Systems engineering and logistic analysis personnel join in presenting the proposed configuration and support concept for the prototype aircraft. Special consideration should be given at this review to the risk areas remaining and support problems that exist, together with a general plan of addressing these areas during Development and Operational Testing (DT/OT I and II). Following the SDR, the contractors prepare the Development Specification, which, as modified by the Navy, establishes the Allocated Baseline for FSD effort.

Logistic Design Appraisal

This design appraisal serves the same purpose as noted in the discussion of the Conceptual Phase. The importance of keeping the "user" on board in the subsequent System Impact Review cannot be overemphasized if a satisfactory vehicle is to be fielded with a satisfactory support concept. It also allows the "user" to plan for operational tests and support.

Preliminary Logistic Support Requirements Identification

Based on the prototype design and LSA effort, including the results of the non-economic LOR analysis, broad, but further refined, support requirements are developed based on a LSAR update corresponding to each contractors' prototype design. These requirements (plus the influence of deficiencies noted as a result of support problem identification) provide the basis for contractor preparation of a Detailed ILS Plan with definitive milestones, for implementation during FSD, and for use at DSARC II, the time of the Full Scale Development Decision. Figure 2 represents the major data items generated in this acquisition phase.

*PRELIMINARY LOGISTIC SUPPORT

REQUIREMENTS IDENTIFICATION

Maintenance Planning

1. Broad Maintenance Concept
2. Maintenance Planning Factors
3. Initial R & M Parameters
4. Initial Repair Level Data

Support and Test Equipment

1. Initial Support and Test Equipment Parameters
2. Initial Support and Test Equipment Requirements
3. Initial Existing Equipment Lists

Supply Support

1. Recommended Support Concept
2. Initial Government Furnished Equipment (GFE) List
3. Initial Standardization Data

Transportation and Handling

1. Initial Handling Equipment Parameters
2. Special Storage and Storage Requirements
3. Initial Existing Equipment List

Figure 2, VALIDATION PHASE

LSA DATA FOR ILS MANAGEMENT REVIEW

*PRELIMINARY LOGISTIC SUPPORT

REQUIREMENTS IDENTIFICATION

Technical Data

1. Preliminary Technical Data Plan
2. Operational Technical Data Factors

Facilities

1. Initial Facility Requirements
2. Existing Facility Availability
3. Initial Facility Requirements Plan

Personnel, Training and Training Equipment

1. Preliminary Manpower Requirements
2. Preliminary Training Requirements
3. General Training Equipment Specifications

*Accomplished to the level that Validation Phase design permits.

NOTE: These requirements are slightly expanded from MIL-STD-1388-1[5:21]

Figure 2-Cont'd., VALIDATION PHASE

LSA DATA FOR ILS MANAGEMENT REVIEW

SECTION VI

LSA PROCESS - FULL SCALE DEVELOPMENT PHASE

Reference; 5:2-21, 10, 11, and 12.

Functional Requirements Identification/System Impact Review

With one contractor's design approach having been selected as a result of the Validation Phase competition, and with system, subsystem, weapon replaceable assembly, and major component identification resulting from the prototyping effort, formalized functional requirements for design and support are established based on the contractor prepared Development Specification/Allocated Baseline, as modified by the Navy for FSD use. A preliminary economic LOR analysis is conducted to formalize planned levels of repair and provide inputs to detail design. The iterative process of support synthesis and trade-off analysis is continued to finalize the system design prior to the Preliminary Design Review (PDR). System, subsystem, weapon replaceable assembly and major component design is documented in engineering drawings to provide the basis for Navy review, approval, and subsequent detail design. At this point in the acquisition cycle, full contractor teams specifically formed to address such disciplines as design, reliability, maintainability, human engineering and safety are engrossed with formal definition of system/subsystem level requirements for support and design constraints.

Another System Impact Review is accomplished with the "user" Command (including other "operationally" oriented organizations) to evaluate system/subsystem level design satisfaction prior to detail design. This assessment of the impact of the new aircraft weapon system design on the existing Service operational and support systems includes such considerations as depot workload and scheduling, provisioning and inventory factors, personnel factors, training/training equipment factors and requirements, technical manual requirements, and transportability requirements. The assessment is conducted in the light of support characteristics embodied in the design.

General Logistic Support Requirements Identification

Following a LSAR update to ensure a current data bank exists, outputs are produced to document the requirements for each support element. Utilizing the LSA data outputs, a LSA Data Verification is accomplished to assess logistic support system capability to support the weapon system effectively and economically. As necessary, trade-off studies are conducted to optimi_e system, subsystem, weapon replaceable assembly and major repairable component design with desired support characteristics. This is a critical period since the baseline established and presented at the PDR guides the detail design effort.

Preliminary Design Review

System engineering and logistic support analysis personnel join to present the system level design and logistic support characteristics to the Navy. Approval of the formal system level design launches the FSD detail design effort.

Detail LSA Process

The iterative LSA process continues to follow the depth of design, and design and support characteristics are progressively established and entered into the LSAR to the component level (based on U. S. Navy/contractor selection of subsystems and repairable components) as detail design of subsystems is completed. A final economic LOR analysis is accomplished to verify previous determinations, and expand the analysis to the range of repairable components desired. The approved levels of repair are input to the LSAR and output to each functional support element discipline. Time is critical in the detail design period, and logistic support analysis must proceed rapidly to allow feedback to be provided in time to have an impact prior to final design release.

Logistic Design Appraisal

Based on detail design release and functional logistic requirements identification, a logistic design appraisal is accomplished. Specific considerations include the following:[5:12]

1. Logistic Support for the total system.
2. Physical Configuration, including structural arrangement, installation, controls, displays, accessibility of components, and transportability.
3. Maintainability considerations such as operational performance monitoring, built-in test capability, on-line versus off-line test requirements, component interchangeability, modularization, accessibility, criticality, standardization and human engineering factors.
4. System and component reliability or malfunction rate/mode of assembly.

Detail Logistic Support Requirements Identification

Complete identification of logistic requirements is accomplished based on the detail design and related maintenance characteristics, as established in the LSAR.

When complete, this record documents all support requirements for the weapon system. Most aircraft manufacturers have EDP systems for documenting and maintaining support equipment and supply support requirements. It may be practical to interface these systems with the LSAR to complete the total record. Figure 3 represents the major data items generated in this acquisition phase.

LSA Data Verification/Trade-Off Analysis

As detail design is progressively completed, the LSAR is updated to ensure that decisions incorporated in the final design are clearly identified in the record. As necessary, trade-off analyses are conducted to optimize support and design considerations.

Critical Design Review (CDR)

A CDR is accomplished late in FSD or early in the low-rate production period. This joint presentation by system engineering and logistic support analysis personnel of the final detail design and support characteristics leads to approval for release of drawings for production and establishment of the Product Specification and Product Baseline.

*GENERAL/DETAILED LOGISTIC SUPPORT

REQUIREMENTS IDENTIFICATION

Maintenance Planning

1. Definitized Maintenance Plan
2. Complete Failure Mode and Effects Analysis
3. Maintenance Actions/Task Data
4. Qualitative and Quantitative R & M Data
5. Total Maintenance Required by Location
6. Repair Level Determination

Support and Test Equipment

1. Complete Support and Test Equipment Identification (Common and Peculiar)
2. Support and Test Equipment Functions and Capability
3. Maintenance Levels where Required
4. Quantities per A/C, Squadron and Support Level
5. Calibration/Measurement Requirements
6. LSA for Complex Support and Test Equipment Items

Supply Support

1. Detailed Supply Support Concept
2. Complete G.F.E. List

Figure 3, FULL SCALE DEVELOPMENT PHASE

LSA DATA FOR ILS MANAGEMENT REVIEW

*GENERAL/DETAILED LOGISTIC SUPPORT

REQUIREMENTS IDENTIFICATION

3. Complete Standardization Data

4. Spare and Repair Parts Recommendations for DT/OT III Tests and Interim (Augmented) Support

Transportation and Handling

1. Storage and Stowage Data

2. Handling Equipment Lists (Common and Peculiar)

Technical Data

1. Technical Data Manual Requirements

   - Operational
   - Organizational Maintenance
   - Intermediate Maintenance
   - Depot Maintenance

Facilities

1. Complete Facilities Plan

2. Facilities Design Criteria

3. Facility Description and Utilization

4. Facility Costs and Schedules

Figure 3-Cont'd., FULL SCALE DEVELOPMENT PHASE

LSA DATA FOR ILS MANAGEMENT REVIEW

*GENERAL/DETAILED LOGISTIC SUPPORT

REQUIREMENTS IDENTIFICATION

Personnel, Training, and Training Equipment

1. Operator and Maintenance Manpower (Quantity and Skills)

2. Personnel Training Requirements

3. Detail Specifications for Training Equipment

*Applies to all FSD LSA iterations in increasing detail.

NOTE: Revised and Expanded from MIL-STD-1388-1,[5:21] but not intended to be all-inclusive.

Figure 3-Cont'd., FULL SCALE DEVELOPMENT PHASE

LSA DATA FOR ILS MANAGEMENT REVIEW

SECTION VII

LSA/PROCESS - PRODUCTION/DEPLOYMENT PHASE

Reference; 5:2-21, 10, 11, and 12.

Impacts from Tests and Deployment

The low-rate production authorization is normally initiated prior to FSD completion to provide program continuity between FSD and Production, and to permit long-leadtime procurement of material. As previously noted, the LSAR was frozen after the Critical Design Review at the end of FSD. Only impact from contractually authorized Engineering Change Proposals (ECP's) may modify the LSAR from this point forward. One may expect a number of changes as a result of Board of Inspection and Survey (DT-III Tests) and Operational Test and Evaluation (OT-III Tests) results.

ECP's are normally subject to the LSA process. Accordingly, as ECP's are implemented the initial action is to review historical data, if appropriate, to establish R & M and supportability factors for design direction. As design progresses and system and detail design is approved, it may be desirable to conduct trade-offs of alternative design approaches. Depending on the magnitude of the ECP's, System Impact Reviews are conducted with the "user" to ensure that design and support characteristics are compatible with the existing Service logistic system. Similar to actions in previous weapon system acquisition phases, the LSA and system engineers work in concert to produce an optimum design for performance and logistic support requirements.

Logistic Design Appraisal

When ECP implementation has resulted in an established design, the LSA and system engineers join in presenting the proposed design in formal design reviews with the procuring agency. The common design objectives achieved in the LSA and system engineering process for each ECP results in modification of the Product Specification and Product Baseline, and leads to final Detail Logistic Support Requirements Identification. It should be remembered that the LSA process is highly iterative, and LSA data has been progressively fed to the functional logistic support element managers to permit evaluation and recommendation of changes to logistic support assets being procured.

Detail Logistic Support Requirements Identification

Based on final ECP design approval, support element changes are finalized and appropriate data updates are accomplished in the LSAR. With final update of the LSAR, each support discipline finalizes changes required to logistic support assets. It may be appropriate to conduct final trade-offs of support element requirements at this time. During testing of ECP fixes the LSA and system engineers observe the effectiveness of design established in weapon system hardware. Concurrent with this test effort, proposed changes to support element assets such as technical manuals and support equipment are also evaluated as part of the LSA Data Verification process. ECP's resulting from changes mandated by operational/deployment experience are subject to the same iterative process.

Although not discussed in detail in this report, LSA engineer participation in DT/OT III tests is mandatory (even if only as observers) to ensure proper and complete evaluation of design and logistic support. This same participation is required in the maintainability demonstration conducted by the procuring agency and the "user".

SECTION VIII

SUMMARY

Conclusions

The basic issue and primary thrust of MIL-STD-1388-1 and -2 is that LSA must be an integral part of the highly iterative system engineering process. The system engineering and LSA processes are tied together in the pursuit of common design/operational support goals. Documentation of goal achievement is accomplished through progressive development of formal weapon system specifications and design baselines throughout the acquisition life cycle. The LSA role in developing a truly "Integrated Logistic Support Program" is twofold. First, integration is accomplished through establishment of functional/physical design characteristics and subsequent final detail design with full operational support considerations. Secondly, integration is accomplished by providing a common family tree of weapon system maintenance plans and maintenance/operational factors to be used by the functional support element managers to ensure development of complimentary support assets.

Positive interface must be maintained with the procuring agency-NAVAIRSYSCOM, the "user" fleet organizations, depot, and U. S. Navy training/training equipment organizations. The Integrated Logistic Support Management Team concept ensures this interface.

Prime contractor logistic support management must acquire system engineering and operations research personnel, with logistic backgrounds, capable of effectively communicating and interfacing with the formal engineering organization personnel.

Location of a Resident Integrated Logistic Support Detachment in the prime contractor facility is mandatory to ensure effective and efficient review and approval of design and plans for logistic support.

Application of the LSA process to specific weapon system programs should be accomplished through translation of MIL-STD-1388-1 and -2 standards first into an update of AR-30A specification requirements, and second into MIL-HDBK 240 guidelines for performance.

Requirements for LSA must be contractually implemented as an integral part of the Systems Engineering Management Plan, Integrated Logistic Support Plan, and Contract Data Requirements List (CDRL).

Finally, LSA is to be applied on a selective basis to critical subsystems, weapon replaceable assemblies and repairable components. LSA is an expensive process, and full consideration must be given to cost versus benefit trade-offs in program definition.

Recommendations

1. Co-locate logistic system engineers and operation research engineers with system, reliability, and maintainability engineers in the functional engineering organization assigned to the specific weapon system project.

2. Establish the LSA process in the Conceptual Phase and ensure continuity throughout the weapon system life cycle in consonance with the system engineering process, and in support of major program milestones. From the Validation Phase forward the prime contractor should build and maintain the LSAR. Magnetic tapes of the LSAR

data base should be provided to NAVAIRSYSCOM to build a historical data base for use on future programs, and to permit independent assessment and trade-off studies as the weapon system program progresses.

3. Delay spare and repair parts provisioning (although MIL-STD-1388-1 calls for spare and repair parts provisioning data to be developed in the FSD phase) until DT/OT III tests are completed and design is modified as required, initial fleet operational experience is gained, and subsystem/component design maturity is reasonably achieved. The benefits from this approach are twofold. First, the reduction of initial spares investment cost by procurement of an austere range and depth of assets (until significant usage data is generated) to be intensively managed by dedicated contractor personnel during the augumented or interim support program is significant. Secondly, avoidance of unnecessary costs associated with procurement of spare and repair parts which may become obsolete due to engineering changes. U. S. Navy Aviation Supply Office (ASO) provisioning plans should be developed for time-phased implementation as individual subsystem design matures, rather than on the basis of a total weapon system provisioning/procurement approach.

4. Translate MIL-STD-1388-1 and -2 LSA standards into an update of AR-30A ILS specification requirements, followed by preparation of MIL-HDBK-240 guidelines for performing LSA.

Implications

The LSA process and standards established in MIL-STD-1388-1 and -2 have the potential for providing a real impact on the generation of NAVAIRSYSCOM weapon system functional requirements and design. Much work remains to be accomplished by NAVAIRSYSCOM ILS policy and plans personnel to generate the methodology for consistent application of requirements. Subsequent to establishment of government techniques for application to specific weapon system programs, prime contractors also have a major task in establishing EDP programs for the LSAR, and in selecting or developing appropriate technical modeling techniques for such applications as predicting availability and reliability, and conducting support and maintenance simulations.

LSA-01 LOGISTIC SUPPORT ANALYSIS

DIRECT ANNUAL MAINTENANCE MAN-HOURS BY SSC AND CATEGORY OF MAINTENANCE

DATE-12/13/73 PAGE 1

END ITEM CODE	FGC	ITEM NAME	PART NO	SERV DES CD
TESTOA	01	ENGINE	E123456789123456 7891234567A	A

SSC	ANNUAL CREW OPERATING M/H	OPER/CREW	ORG	DIRECT SUPPORT/IMA	GENERAL SUPPORT (ARMY)	DEPOT
2121212	.00	.00	11.00	.00	.00	.00
2222222	.00	.00	.00	3.00	4.00	6.00
3333333	.00	.00	.00	7.00	8.00	11.00
4444444	.00	.00	12.00	.00	8.00	11.00
5555555	.00	.00	2.00	.00	50.00	2.00
6666666	.00	.00	6.00	35.00	.00	30.00
7777777	.00	.00	12.00	41.00	.00	.00
8888888	.00	.00	20.00	.00	.00	.00

APPENDIX A

SAMPLE LSAR REPORT OUTPUTS

LSA-02

LOGISTIC SUPPORT ANALYSIS

PERSONNEL AND SKILL SUMMARY

DATE 12/13/73 PAGE 1

END ITEM CODE TESTDA FGC 0 SERV DES CD A

SSC	FGC	TASK CODE	TASK FREQ	SS EVALUATION ADEQ MOD NEW	NO. MEN	MAN HOURS	TRNG EQUIP	DISTRIBUTION OF ANNUAL MAINTENANCE MAN-HOURS OPER/CREW	ORGANIZATIONAL	DIRECT SUPPORT/IMA	GENERAL SUPPORT (ARMY)	DEPOT
1111111	0	BDCXXAA	50.00	A	01	.60	N	30.00				
	02	ARCXXBA	3.00	A	01	3.00	N	9.00				
		BBCXXBA	2.00	A	01	2.00	N	4.00				
	03	NGOXXAA	5.00	A	02	2.00	N		10.00			
TOTAL MAINTENANCE MAN-HOURS FOR SSC 1111111								43.00	10.00	.00	.00	.00
2121212	01	HGOXXAE	1.00	A	01	1.00	N		1.00			
		HGOXXAF	1.00	A	01	1.00	N		1.00			
		HGOXXAG	1.00	A	01	1.00	N		1.00			
		HGOXXAH	1.00	A	01	1.00	N		1.00			
		HGOXXAI	1.00	A	01	1.00	N		1.00			
		HGOXXAJ	1.00	A	01	1.00	N		1.00			
		HGOXXAK	1.00	A	01	1.00	N		1.00			
		HGOXXAL	1.00	A	01	1.00	N		1.00			
		HGOXXAM	1.00	A	01	1.00	N		1.00			
		HGOXXAN	1.00	A	01	1.00	N		1.00			
		HGOXXAO	1.00	A	01	1.00	N		1.00			
TOTAL MAINTENANCE MAN-HOURS FOR SSC 2121212								.00	11.00	.00	.00	.00
2222222	0	OCCXXAA	100.00	A	01	5.00	Y	500.00				
	01	FFFXXBA	3.00	A	01	1.00	N			3.00		
	0101	NGDXXYA	3.00	A	02	2.00	N					6.00
	0102	JGHXXYA	1.00	A	01	2.00	N				2.00	
		NGHXXYA	1.00	A	01	2.00	N				2.00	
	02	JGFXAAA	1.00	A	01	1.00	N			1.00		
	03	AHOXXBA	20.00	A	02	20.00	Y		400.00			
TOTAL MAINTENANCE MAN-HOURS FOR SSC 2222222								500.00	400.00	4.00	4.00	6.00
3333333	0	HGFXX9A	1.00	A	01	20.00	N			20.00		
		PHOXXAA	5.00	A	01	.50	N		2.50			
	01	HGFXXAA	1.00	A	01	2.00	Y			2.00		
	0101	JGDXXYA	3.00	A	01	3.00	N					9.00
	010203	NGDXXYA	1.00	A	01	2.00	N					2.00
	02	NGOXXAA	1.00	A	01	2.00	N		2.00			
	03	CDOXXAA	5.00	A	02	20.00	N		100.00			
TOTAL MAINTENANCE MAN-HOURS FOR SSC 3333333								.00	104.50	22.00	.00	11.00

LSA-09

LOGISTIC SUPPORT ANALYSIS

REPAIR SUMMARY

FOR

DATE 12/13/73 PAGE 2

SERV DES CD 0

A

FGC MAX ALLOW OPER TIME	TASK FUNC ITM CAT CD	PART NUMBER FSN	FSCM SMR	ITEM NAME REFERENCE DES		USE ON CODE	S/L U/M	PROC CONCEPT CODE	QTY PER ASSY	QTY END ITM	MAINT REP RATE	OHL RFP RATE	TOTAL QTY RECM	MFC SEC	P L T	UNIT PRICE TOTAL PRICE
010304 100	J G	CCC MMMM1111999I1111MMMM	66666 MHOZL	BOLT-3 A34		A	Z EA	0	3		5 3203.2	3203.2	30	6 G	03	$1.00 $30.00
010305 10	J G	DDD MMMM1111000I1111MMMM	66666 MOOZA	BOLT-4 A36		ABCD	4 EA	0	2		6 3303.3	3303.3	10	7 H	01	$50.00 $500.00
0104 1245	O G	E14 MMMM1111PPPI111MMMM	22222 AF070	WATER PUMP A11	1	ABCD	P EA	0	1		1 1401.4	1401.4	200	1 U	03	$2.00 $400.00
0201 20	J G	S11 MMMM1111RRRI111MMMM	33333 ADOZH	MOUNTS A13	1	AB	R EA	0	4		4 1601.6	1601.6	300	5 B	03	$.25 $75.00
0202 10	J G	S12 MMMM1111SSSI111MMMM	33333 XAOZD	SHOCKS A14	1	A	S EA	0	4		4 1701.7	1701.7	10	6 C	04	$4.00 $40.00
0203 30	J G	S13 MMMM1111TTT1111MMMM	33333 XBOZL	SPRINGS A15	2	ABCD	T EA	0	4		4 1801.8	1801.8	20	7 G	05	$4.00 $80.00
0204 100	J G	AAA MMMM1111777I111MMMM	66666 MOOZH	BOLT-1 A28		AB	8 EA	0	12		26 3003.0	3003.0	100	3 B	01	$.20 $20.00
030101 100	J G	AAA MMMM11117771111MMMM	66666 MOOZH	BOLT-1 A29		AB	8 EA	0	4		26 3003.0	3003.0	100	3 B	01	$.20 $20.00
030102 30	J G	D111 MMMM1111WWW1111MMMM	44444 PBOZO	UNIVERSAL A18	1	A	V EA	0	2		2 2102.1	2102.1	50	5 K	01	$2.05 $102.50
030103 21	J G	D112 MMMM1111XXXI111MMMM	44444 PCOZF	SHAFT A19	2	ABC	W EA	0	1		1 2202.2	2202.2	250	6 L	01	$.50 $125.00
030201 20	J G	D121 MMMM1111111I1111MMMM	55555 PEOZD	GEAR-1 A21		A	X EA	0	2		2 2402.4	2402.4	20	1 J	01	$3.00 $60.00
030202 10	J G	D122 MMMM11112221111MMMM	55555 PFOZL	GEAR-2 A22	2	A	4 EA	0	2		2 2502.5	2502.5	10	3 D	01	$10.00 $100.00
030203 100	J G	AAA MMMM11117771111MMMM	66666 MOOZH	BOLT-1 A30		AB	8 EA	0	6		26 3003.0	3003.0	100	3 B	01	$.20 $20.00
030204 100	J G	BBB MMMM1111888I111MMMM	66666 MFOZD	BOLT-2 A31		A	9 EA	0	4		14 3103.1	3103.1	10	5 C	01	$20.00 $200.00

LSA-13

LOGISTIC SUPPORT ANALYSIS

SUPPORT EQUIPMENT REQUIREMENTS BY CATEGORY OF MAINTENANCE

DATE 12/13/73

END ITEM CODE	FGC	SERVICE DFS CODE
TESTDA	0	A

SUPPORT EQUIPMENT GROUPING IDENTIFICATION NUMBER 200

MAINT LEVEL	FUNCTIONAL GROUP CODE	TASK CODE	TASK FREQ	M B	ELAPSED TIME
CREW MAINT	02	AHCXXBA	3.00	H	3.00
DEPOT	0	KPDXXAA	1.00	H	17.00
	01	KRDXXAA	3.00	H	5.00
	0101	GGDXXYA	2.00	H	1.00
	010203	LBDXXYA	1.00	H	6.00
DIRECT SUPPORT	0	MGFXXBA	1.00	H	20.00
	01	MGFXXAA	1.00	H	2.00

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LOGISTIC SUPPORT ANALYSIS

ORGANIZATIONAL REPAIR PARTS LIST

DATE 12/13/73 PAGE 1

FOR

0

FGC	SMR	FEDERAL STOCK NO	ITEM NAME	USABLE ON CODE	UM	15 DAY ORG MAINT ALW (A) 1-5	(B) 6-20	(C) 21-50	51-100	FIGURE AND ITEM	REFERENCE DESIGNATOR	
010104	MOO7M	MMMM11117771111MMMM	BOLT-1	AB	EA	0030	0030	0030	0030		A27	
010201	PGOZA	MMMM1111GGG1111MMMM	END PLATE	AYX	EA	0007	0007	0007	0007		A2	1
010202	MHOZL	MMMM11119991111MMMM	BOLT-3	A	EA	0032	0032	0032	0032		A33	
01020301	KFOZO	MMMM1111III1111MMMM	CORE	ABC	EA	0009	0009	0009	0009	A4		
01020302	KBOZF	MMMM1111JJJ1111MMMM	COIL	ABC	EA	0010	0010	0010	0010	A5		
01020303	MOOZA	MMMM1111OOO1111MMMM	BOLT-4	ABCD	EA	0033	0033	0033	0033		A35	
010204	MOO7M	MMMM1111KKK1111MMMM	ARMATURE	AB	EA	0001	0002	0003	0004	A6		
010205	MFO7D	MMMM1111LLL1111MMMM	BRUSH	ABCD	EA	9999	9999	9999	9999		A7	1
010302	MOOZA	MMMM1111NNN1111MMMM	PLATE	AB	EA	0012	0012	0012	0012		A9	1
010303	AOOZZ	MMMM1111OOO1111MMMM	POINTS	CCCC	EA	0013	0013	0013	0013	A10		
010304	MHOZL	MMMM11119991111MMMM	BOLT-3	A	EA	0032	0032	0032	0032		A34	
010305	MOOZA	MMMM1111OOO1111MMMM	BOLT-4	ABCD	EA	0033	0033	0033	0033		A36	
0104	AFOZO	MMMM1111PPP1111MMMM	WATER PUMP	ABCD	EA	0014	0014	0014	0014		A11	1
0201	AOOZM	MMMM1111RRR1111MMMM	MOUNTS	AB	EA	0016	0016	0016	0016		A13	1
0202	XAOZD	MMMM1111SSS1111MMMM	SHOCKS	A	EA	0017	0017	0017	0017		A14	1
0203	XBOZL	MMMM1111TTT1111MMMM	SPRINGS	ABCD	EA	0018	0018	0018	0018	A15		
0204	MOOZM	MMMM11117771111MMMM	BOLT-1	AB	EA	0030	0030	0030	0030		A28	
030101	MOOZM	MMMM11117771111MMMM	BOLT-1	AB	EA	0030	0030	0030	0030		A29	
030102	PBOZO	MMMM1111WWW1111MMMM	UNIVERSAL	A	EA	0021	0021	0021	0021		A18	1
030103	PCOZF	MMMM1111XXX1111MMMM	SHAFT	ABC	EA	0022	0022	0022	0022	A19		
030201	PEOZD	MMMM11111111111MMMM	GEAR-1	A	EA	0024	0024	0024	0024		A21	
030202	PFOZL	MMMM11112221111MMMM	GEAR-2	A	EA	0025	0025	0025	0025	A22		

REPAIR PARTS LIST

FOR

0

FGC	SMR	FEDERAL STOCK NO	ITEM NAME	MODEL	UM	30 DAY MAINTENANCE ALLOWANCE DIRECT SUPPORT (A) 1-20	(B) 21-50	(C) 51-100	GENERAL SUPPORT (A) 1-20	(B) 21-50	(C) 51-100	YR QTY CNTG	1 YR DEPOT MAINT ALLW	REFFRENCE DESIGNATOR	
010101	PCDZF	MMMM1111CCC1111MMMM	CRANK	TEST	EA	3	3	3	3	3	3	3	3	ABCD	2
010102	PDFAM	MMMM1111DDD1111MMMM	BEARING	TEST	EA	4	4	4	4	4	4	4	4	ABCDE	1
010103	PEMZD	MMMM1111EFE1111MMMM	CAP	TEST	EA	5	5	5	5	5	5	5	5	ABCDEF	2
010104	MOOZH	MMMM11117771111MMMM	BOLT-1	TEST	EA	30	30	30	30	30	30	30	30	A27	
010201	PGOZA	MMMM1111GGG1111MMMM	END PLATE	TEST	EA	7	7	7	7	7	7	7	7	A2	1
010202	MHOZL	MMMM11119991111MMMM	BOLT-3	TEST	EA	32	32	32	32	32	32	32	32	A33	
01020301	KFOZO	MMMM1111III1111MMMM	CORE	TEST	EA	9	9	9	9	9	9	9	9	A4	2
01020302	KBOZF	MMMM1111JJJ1111MMMM	COIL	TEST	EA	10	10	10	10	10	10	10	10	A5	2
01020303	MOOZA	MMMM1111OOO1111MMMM	BOLT-4	TEST	EA	33	33	33	33	33	33	33	33	A35	
010204	MOOZH	MMMM1111KKK1111MMMM	ARMATURE	TEST-DATA-	EA	5	6	7	8	9	10	12	11	A6	2
010205	MFOZO	MMMM1111LLL1111MMMM	BRUSH	TEST-DATA-	EA	9999	9999	9999	9999	9999	9999	9999	9999	A7	1
010302	MOOZA	MMMM1111NNN1111MMMM	PLATE	TEST	EA	12	12	12	12	12	12	12	12	A9	1
010303	AOOZZ	MMMM1111OOO1111MMMM	POINTS	TEST	EA	13	13	13	13	13	13	13	13	A10	2
010304	MHOZL	MMMM11119991111MMMM	BOLT-3	TEST	EA	32	32	32	32	32	32	32	32	A34	
010305	MOOZA	MMMM1111OOO1111MMMM	BOLT-4	TEST	EA	33	33	33	33	33	33	33	33	A36	
0104	AFOZO	MMMM1111PPP1111MMMM	WATER PUMP	TEST	EA	14	14	14	14	14	14	14	14	A11	1
0201	AOOZH	MMMM1111RRR1111MMMM	MOUNTS	TEST	EA	16	16	16	16	16	16	16	16	A13	1
0202	XAOZO	MMMM1111SSS1111MMMM	SHOCKS	TEST	EA	17	17	17	17	17	17	17	17	A14	1
0203	XBOZL	MMMM1111TTT1111MMMM	SPRINGS	TEST	EA	18	18	18	18	18	18	18	18	A15	2
0204	MOOZH	MMMM11117771111MMMM	BOLT-1	TEST	EA	30	30	30	30	30	30	30	30	A28	
030101	MOOZH	MMMM11117771111MMMM	BOLT-1	TEST	EA	30	30	30	30	30	30	30	30	A29	
030102	PBOZO	MMMM1111WWW1111MMMM	UNIVERSAL	TEST	EA	21	21	21	21	21	21	21	21	A18	1

LSA-04 LOGISTIC-SUPPORT-ANALYSIS

MAINTENANCE ALLOCATION SUMMARY

SERV DES CD 4 END ITEM NAME VEHICLE END ITEM FGC 0 REPORT DATE 12/13/73 PAGE NO 3

TASK REQUIREMENTS BY MAINT LEVEL/CATEGORY/SKILLS/MAN-HOURS

ITM NO		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRT	INSTALL	REPLACE	REPAIR	OVERHAL	REBUILD	PROF CH	FAULT LO	OPERATE	SUB	DISASY
		A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q
00004 FGC 0102 (NAME)GENERATOR (P/N)E12 (QTY)00001 (SMR)PFDOL (MIL/E) 1 (F/R)06006 (O/R)06006																	
	M L				H		H		F	H				H			
	SSC				3333333		3333333		7777777	2222222				2222222			
	M-H				1.00		2.00		2.00	2.00				2.00			
00005 FGC 010203 (NAME)FIELD-ASSEMBLY (P/N)E123 (QTY)00001 (SMR)KDOOZ (MIL/E) 5 (F/R)08008 (O/R)08008																	
	M L		F					F		D		D		D			
	SSC		6666666					6666666		4444444		4444444		3333333			
	M-H		2.00					1.00		3.00		6.00		2.00			
	SSC							7777777									
	M-H							1.00									
00006 FGC 0103 (NAME)MAG (P/N)E13 (QTY)00001 (SMR)MHOHL (MIL/E) 5 (F/R)11011 (O/R)11011																	
	M L	F	H				F		F	H							
	SSC	6666666	5555555				7777777		6666666	4444444							
	M-H	6.00	10.00				8.00		2.00	4.00							
00007 FGC 02 (NAME)SUSPENSION (P/N)S1 (QTY)00001 (SMR)AHOFF (MIL/E) 3 (F/R)15015 (O/R)15015																	
	M L	C	C	O	F					F				O			
	SSC	1111111	1111111	5555555	4444444					2222222				3333333			
	M-H	3.00	2.00	1.00	.50					1.00				2.00			
00008 FGC 03 (NAME)DRIVE-TRAIN (P/N)D1 (QTY)00001 (SMR)XCOOA (MIL/E) 1 (F/R)19019 (O/R)19019																	
	M L	O		O										O		O	O

LSA-20

LOGISTIC SUPPORT ANALYSIS

TOOL AND EQUIPMENT REQUIREMENTS

DATE 12/12/73 PAGE NO 1

FOR

01

ITEM NUMBER	FGC	ITEM CAT CODE	TASK FUNCTION	MAINTENANCE CATEGORY	ITEM NAME	MFR PART NO
23	01	A	H	F	HOIST	HH
		A	A	O	TESTER-2	T2
24	0101	A	N	D	TESTER-1	T1
		D	G	D	SPECIAL JACK	JJ
25	0102	A	N	H	TESTFR-2	T2
27	0103	A	B	H	TESTER-1	T1
		A	A	F	TESTER-1	T1

LSA-03

RELIABILITY AND MAINTAINABILITY SUMMARY

DATE

END ITEM CODE	FUNCTIONAL GROUP CODE	ITEM NAME	MFR. PART NUMBER	TYPE/MODEL/SERIES DESIG	FSCM
TESTDA	03	DRIVE TRAIN / 01	DR-TR TEST	XX3333333	44444

	RELIABILITY FACTORS MTBF	MTBMA	MAINTAINABILITY FACTORS MTTR	MAMDT	MPMDT	AVAILABILITY FACTORS INHERENT	ACHIEVED
REQD -	400.0	350.0	2.0	3.0		98.00%	93.00%
ALLOC-			2.2	5.7	6.8		
PRED -	23.8	6.0	2.2	5.7	6.8	91.00%	51.00%
MEAS -			2.2	5.7	6.8		

HIGH 5 SCHEDULED MAINTENANCE

TASK NAME	FREQ	ITEM NAME	ITEM PART NUMBER	TASK TIME
ADJUST	83 HR	REAR END	D13	5.00 HR
LUBRICATE	100 HR	TRANSMISSION	D12	5.00 HR
SERVICE	100 HR	DRIVE TRAIN	D1	10.00 HR
LUBRICATE	100 HR	DRIVE TRAIN	D1	5.00 HR

HIGH 5 UNSCHEDULED MAINTENANCE

TASK NAME	FREQ	ITEM NAME	ITEM PART NUMBER	TASK TIME
FAULT LOC	100 HR	DRIVE TRAIN	D1	1.00 HR
REMV-REPL	250 HR	TRANSMISSION	D12	2.00 HR
REMV-REPL	250 HR	DRIVE SHAFT	D11	1.00 HR
REMV-REPL	250 HR	REAR END	D13	1.00 HR

ORGANIZATIONAL MAINT TOTALS

	DAILY INSPECTION HOURS ELAP	MAN	PREOPERATIVE INSPECTION HOURS ELAP	MAN	POSTOPERATIVE INSPECTION HOURS ELAP	MAN	INTERMEDIATE INSPECTION HOURS ELAP	MAN
REQD -	1.3	2.3	3.3	4.3	5.3	6.3	7.3	8.3
STATUS -	.0	.0	.0	.0	10.0	20.0	.0	.0

	PERIODIC INSPECTION HOURS ELAP	MAN	TURN AROUND TIME HOURS ELAP	MAN	MISSION PROFILE CHANGE HOURS ELAP	MAN
REQD -	9.3	10.3	13.3	14.3	15.3	16.3
STATUS -	.0	.0	3.0	3.0	.0	.0

	M/H PER HR SCHED	UNSCH	ANNUAL MAINT M/H SCHED	UNSCH
REQD -	17.3	18.3	19.3	20.3
STATUS -	1.1	.0	596.0	21.0

INTERMEDIATE/DIRECT SUPPORT MAINT TOTALS

	INTERMEDIATE INSPECTION HOURS ELAP	MAN	PERIODIC INSPECTION HOURS ELAP	MAN
REQD -	21.3	22.3	23.3	24.3
STATUS-	.0	.0	.0	.0

	M/H PER HR SCHED	UNSCH	ANNUAL MAINT M/H SCHED	UNSCH
REQD -	25.3	26.3	27.3	28.3
STATUS-	.1	.0	72.0	11.0

GEN SPT MAINT TOTALS

	M/H PER HR SCHED	UNSCH	ANNUAL MAINT M/H SCHED	UNSCH
REQD -	29.3	30.3	31.3	32.3
STATUS-	.0	.0	36.0	21.0

DEPOT MAINT TOTALS

	M/H PER HR SCHED	UNSCH	ANNUAL MAINT M/H SCHED	UNSCH
REQD -	33.3	34.3	35.3	36.3
STATUS-	.0	.0	.0	.0

LOGISTICS SUPPORT ANALYSIS

SUPPORT EQUIPMENT UTILIZATION SUMMARY

END ITEM CODE TESTDA FGC 0 SERV-DES CODE A DATE 12/12/73 PAGE NO 1

SUPPORT EQUIPMENT MFR PART NUMBER	ITEM NAME	UNIT PRICE	ITEM CATEGORY PECULIAR COMMON	PROCUREMENT METHOD CODE	SMR CODE
HH	HOIST	$50.00	A	0	AHOLF

MAINT LEVEL CATEGORY	FGC	TASK CODE	TASK FREQ	MEAS BASE	ELAPSED TIME	QTY PER TASK	REPAIRABLE ITEM NAME	PART NUMBER OF ITEM BEING REPAIRED
CREW	02	ABCXXBA	3.00	H	3.00	1.0	SUSPENSION	S1
D.S./IMA	0	MGFXXBA	1.00	H	20.00	1.0	VEHICLE	V1111111111111112222
	01	MGFXXAA	1.00	H	2.00	1.0	ENGINE	E1234567891234567891234567891234
ORG	03	AHOXXBA	20.00	H	10.00	1.0	DRIVE TRAIN	D1
		NGOXXAA	5.00	H	1.00	1.0		
	0302	MGOXXAA	2.00	H	2.00	1.0	TRANSMISSION	D12

SUPPORT EQUIPMENT MFR PART NUMBER	ITEM NAME	UNIT PRICE	ITEM CATEGORY PECULIAR COMMON	PROCUREMENT METHOD CODE	SMR CODE
T1	TESTER-1	$5.00	A	0	AOOLZ

MAINT LEVEL CATEGORY	FGC	TASK CODE	TASK FREQ	MEAS BASE	ELAPSED TIME	QTY PER TASK	REPAIRABLE ITEM NAME	PART NUMBER OF ITEM BEING REPAIRED
CREW	0	AACXXBA	100.00	H	.70	1.0	VEHICLE	V1111111111111122222
		BDCXXAA	50.00	H	.60	1.0		
DEPOT	0101	NGDXXYA	3.00	H	1.00	1.0	BLOCK	E11
D.S./IMA	0103	ADFXXBA	3.00	H	3.00	1.0	MAG	E13

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609123456AAAG  2                              01NN                                          X001D
609123456AAAG    S        1300                   1400                                        01E
609123456AAAG   0012423023    EA                       PDOOM S1111YYY1111MMMM               01F
609123456AAAG  0153015301530153015301530153015302302302302302302302302302330023            01H
609123456AAAG                                        H000001000G000000                      01J
609123456AAAG    0          001                                                             01K
609123456AAAG  A20                 0302          T                                          01L
609123456AAAG            002300230023002300230023002300230023002300023000023               01N
609123456AAAH  D55555D121                     GEAR-1              55555D12                 N01B
609123456AAAH   00020A                        EA000000300000026666 6DN121                  01C
609123456AAAH                                 01YNY                                        XX001D
609123456AAAH    S         1500                  1600                                       01E
609123456AAAH   0012524024    EA                       PE*DD H11111111111MMMM               01F
609123456AAAH  0160016001600160016001600160024024024024024024024024024024024               01H
609123456AAAH                                        H000002000000000                       01J
609123456AAAH    0          001                                                             01K
609123456AAAH  A21                 030201        J                                          01L
609123456AAAH            0024002400240024002400240024002400240024000240000024              01N
609123456AAAJ  D55555D122                     GEAR-2              55555D12                 N01B
609123456AAAJ   00010A                        EA0000010000000266666DND122                  01C
609123456AAAJ                                 01NN                                         X001D
609123456AAAJ    A         1500                  1600                                       01F
609123456AAAJ   0012625025    EA                       PF*HL L111122211111MMMM              01F
609123456AAAJ  0166016601660166016601660166016602502502502502502502502550 25               01H
609123456AAAJ                                        H000001000000000                       01J
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609123456AAAK  D66666AAA                      BOLT-1              55555D12                 N01B
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609123456AAAK   0013430030    EA                       MO*DH L111177711111MMMM              01F
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609123456AAAK                                                       5555                   02J
609123456AAAK    0          001                                                             01K
609123456AAAK  A30                 030203        B                                          01L
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609123456AAAL  D66666BBB                      BOLT-2              55555D12                 Y01B
609123456AAAL   00010A                        EA0000020000001477777DNBBB                   01C
609123456AAAL                                 01NN                                         X001D
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609123456AAAL   0013531031    EA                       MF*HD S1111BBB1111MMMM               01F
609123456AAAL  0206020602060206020602060206020603103103103103103103103103 11031             01H
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609123456AAAL            003100310031003100310031003100310031003100031000031               01N
609123456AAAM  C55555D13                      REAR END            44444D1                  N01B
609123456AAAM   00010A                        EA000002000000015555DND13                    01C
609123456AAAM                                 01NY                                         X001D
609123456AAAM    T         1500                  1600                                       01E
609123456AAAM   0012726026    EA                       PGOOA S111133311111MMMM              01F
609123456AAAM  0173017301730173017301730173017302602602602602602602602660 26               01H
609123456AAAM                                        H000030000000000                       01J
609123456AAAM    0          001                                                             01K
609123456AAAM  A23                 0303          E                                          01L
609123456AAAM            002600260026002600260026002600260026002600026000026               01N
609123456AAAN  D55555D131                     SHAFT               55555D13                 Y01B
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SELECTION WORKSHEET

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NOTE: Bibliography interview items 9-12 were involved in data gathering and consultation. These interviews were not for the purpose of obtaining study project report approval, nor was such approval provided.

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DEFENSE SYSTEMS MANAGEMENT SCHOOL

STUDY TITLE:

AN OVERVIEW APPROACH TO LOGISTIC SUPPORT ANALYSIS --MAJOR U. S. NAVY AIRCRAFT PROGRAMS

STUDY PROJECT GOALS:

To provide an overview of the LSA process as it interfaces and integrates with the system engineering process throughout the weapon system acquisition life cycle.

To identify the basic intent and benefit of the LSA process and reveal the natural evolution of design through pursuit of common LSA and system engineering goals.

STUDY REPORT ABSTRACT Logistic Support Analysis (LSA)

The purpose of the study project is to provide an understanding of how the basic issue and intent of the LSA process may be applied to a major NAVAIRSYSCOM aircraft program through interface and integration with the system engineering process. Preparatory to study project report preparation analysis of MIL-STD-1388-1 and -2 and associated military standards and specifications, and interviews with the authors of MIL-STD-1388 was completed. The report infuses concepts based on the writers experience as a contractor representative.

The study project report portrays application of the LSA and system engineering processes to the acquisition life cycle of a hypothetical aircraft program involving competitive prototypes in the Validation Phase. An overview of the LSA process is provided as it integrates with the system engineering effort in the progressive establishment of engineering specifications and baselines. Progress is related to design reviews and logistic system appraisals throughout the acquisition life cycle.

Conclusions and recommendations center on the potential for successfully incorporating logistic considerations in aircraft design. Recommendations cover co-location of logistic engineers and operations research analysts within the engineering project, early establishment of the LSA process in the Conceptual Phase in consonance with the depth of the system engineering effort, delay of spare and repair parts provisioning until subsystem design matures and fleet usage data is accumulated, and implementation of the LSA process through translation of MIL-STD-1388 standards into an update of AR-30A specification requirements, and finally preparation of MIL-HDBK-240 guidelines for LSA performance.

The LSA process has the potential to provide a real impact on design. An understanding of the basic intent of LSA as it integrates with the system engineering process is essential to successful application to future NAVAIRSYSCOM aircraft development programs.

NAME, RANK, SERVICE	CLASS	DATE
Robert R. Humphrey Lockheed California Company	PMC-75-2	7 November 1975

KEY WORDS

MATERIEL
DESIGN AND DEVELOPMENT
WEAPON SYSTEMS
LSAR
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AIRCRAFT
CONCEPT FORMULATION
INTEGRATED LOGISTICS SUPPORT
SYSTEMS ENGINEERING