Design and Development of the Missile System
Operation and **S**upport **C**ost **A**nalyze**R**
Model and Database

by

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in

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(Abstract)

During this era in which budget shortfalls are commonplace, it is necessary for program sponsors to have an effective means of estimating and justifying their budgets. Program sponsors rely on cost analysts to complete and defend these detailed budget estimates. The Operation and Support (O&S) portion of a missile system's life cycle accounts for approximately 78%[1] of the total program's costs. Thus establishing a structured means of estimating a missile system's O&S cost will greatly aid cost analysts. Through use of the **O**peration and **S**upport **C**ost **A**nalyze**R** (OSCAR) System, cost analysts and program sponsors will be provided with defendable budgets. The OSCAR system consists of an OSCAR database[2], OSCAR model[3], and methodology on how to maintain the OSCAR system. The design and development of the OSCAR system including the OSCAR model and OSCAR database was completed by Rosemarie Bolha as part of the Project Report submitted to the Faculty of the Virginia Polytechnic Institute and State University.

The OSCAR database consists of Cost Estimating Relationships (CERs) for all of the O&S sub-elements. The majority of the CERs were statistically derived from the data collected from numerous missile systems. This database is used to support and supplement the detailed analyses completed by the OSCAR model. The OSCAR model predicts any missile system's O&S cost. The OSCAR model provides budget estimates and supporting information quickly and reliably. The OSCAR model is

designed with the capability to predict costs for two or three levels of maintenance, calculate a missile's recertification schedule based on a variety of system-in-service-times, and provide the user with both a detailed and a summarized Logistics Requirement Funding Plan[4] report.

By incorporating state-of-the-art system engineering concepts, the OSCAR system is designed with considerations for user friendliness, fulfillment of end users needs, and flexibility. One such concept is a six step analytical approach referred to as a "system life-cycle process." A modified system life-cycle process was used to develop the OSCAR system.

The OSCAR system will be presented to both NAVAIR 524 and NAVAIR 418 (Cost Analysis and Airborne Weapons Logistics Divisions) for their use in estimating O&S cost for missile system's. The OSCAR system will be maintained and annually updated by NAVAIR.

Acknowledgements

I would like to express my thanks to the committee members, NAVAIR 418, the Tomahawk program office, and my other data sources for their time and patience. Thanks to my employer for understanding the importance of personal development.

Thanks to my friends, Julie and Marie, who helped me keep THE PROJECT in perspective. A special thanks to my old man, Chuck, whom's love for me and jealousy of THE PROJECT gave me the extra incentive I needed to complete it. Of course, a deep hearted thanks to my loving parents Frank and Ann who taught me how to be dedicated and how to never give up. And thank god for optimism.

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I. Introduction

A. Purpose

The purpose of this project was to design and develop a missile system's Operation and Support (O&S) cost estimating system. The cost estimating system which was designed and developed for this project is called the **O**peration and **S**upport **C**ost **A**nalyze**R** (OSCAR) System (see Figure 1--**O&S C**ost **A**nalyze**R** (OSCAR) System). Specifically, the OSCAR system can be used to estimate those program sponsor costs associated with the missile system O&S after the Material Support Date (MSD) has occurred. MSD is the date when the responsibility of providing replenishment spares, etc. to the support activities, is performed by the government rather than the developer.

The primary objectives of this project were to:

- Aid analysts in understanding the role that O&S plays in the missile system's life cycle.
- Define O&S cost data collection elements.
- Provide analysts with a missile O&S data collection, normalization, estimating, and maintenance methodology.
- Aid analysts in future O&S cost estimates.

B. Scope

A typical missile system has an estimated life cycle of twenty years. Thus, the O&S costs of maintaining a missile system is an essential

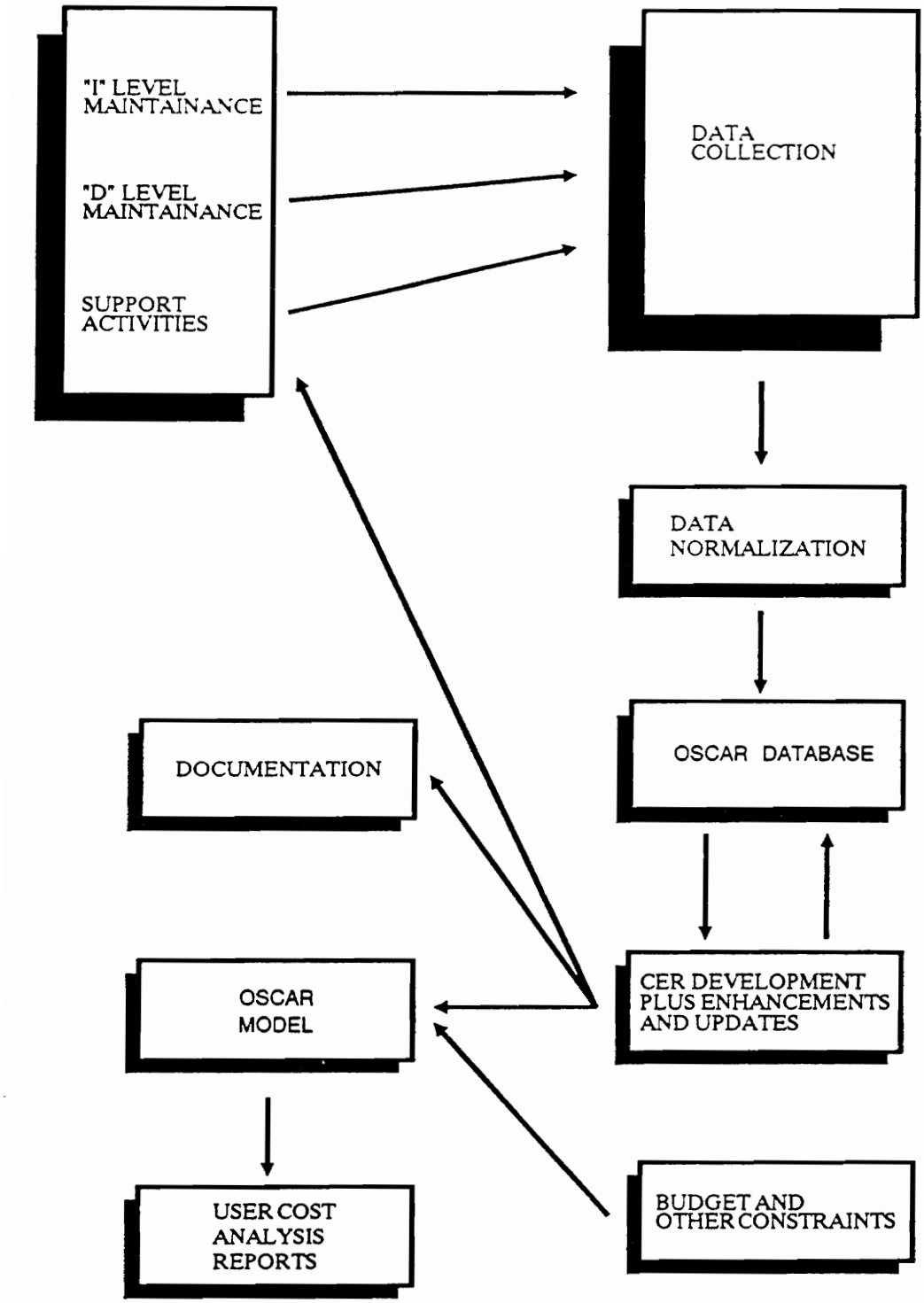


Figure 1 **O & S Cost AnalyzeR** (OSCAR) System

part of a missile system's budget. "O&S costs are the added or variable costs of personnel, materials, facilities, and other items needed for peacetime operation, maintenance and support of a missile system during activation, steady state operation, and disposal."[5] Cost analysts are responsible for estimating and justifying detailed O&S budget estimates. Since no missile system O&S cost estimating system exists, establishing one will greatly aid cost analysts. The objectives of this project and report includes aiding analysts in understanding the role that O&S plays in the missile system's life cycle; and to develop a missile system O&S cost estimating system (OSCAR) which will provide analysts with a database, model, and methodology for collecting, estimating, and maintaining this OSCAR system (see Figure 2--Target "**O&S Cost AnalyzeR** (OSCAR) System" and Figure 1).

C. Approach

The next section of this report, Section II, includes a description of a missile system and explains how the O&S phase relates to the overall missile system life cycle. The next six sections of this report, sections III through VIII, describe the implementation of the six phase OSCAR system life-cycle process as defined below and in Figure 3--**O&S Cost AnalyzeR** (OSCAR) System Life-Cycle Process. Sections IX through XII conclude this report with a summary of the results, conclusions, and recommendations.

As shown by Figure 3 there are six phases of the OSCAR system life-cycle process. These phases contain feedback loops as defined by the diagram. Phase 1 is to identify the need for the missile system O&S

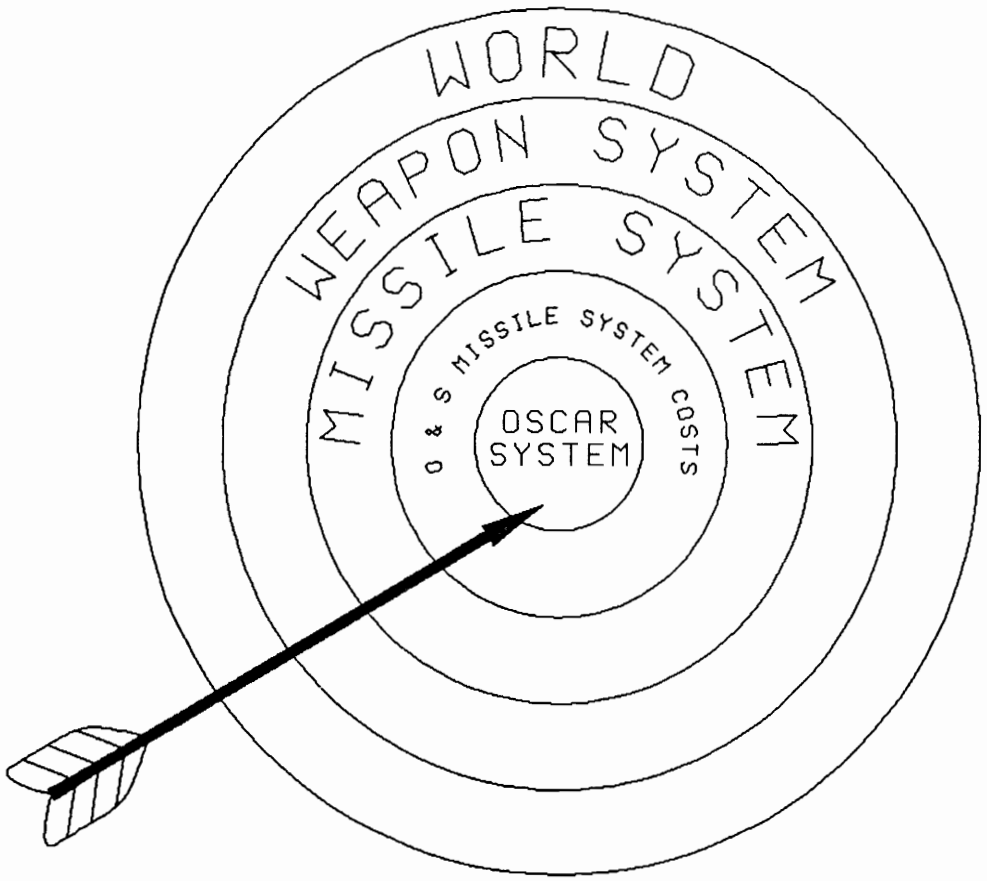


Figure 2 Target "O&S Cost AnalyzeR (OSCAR) System"

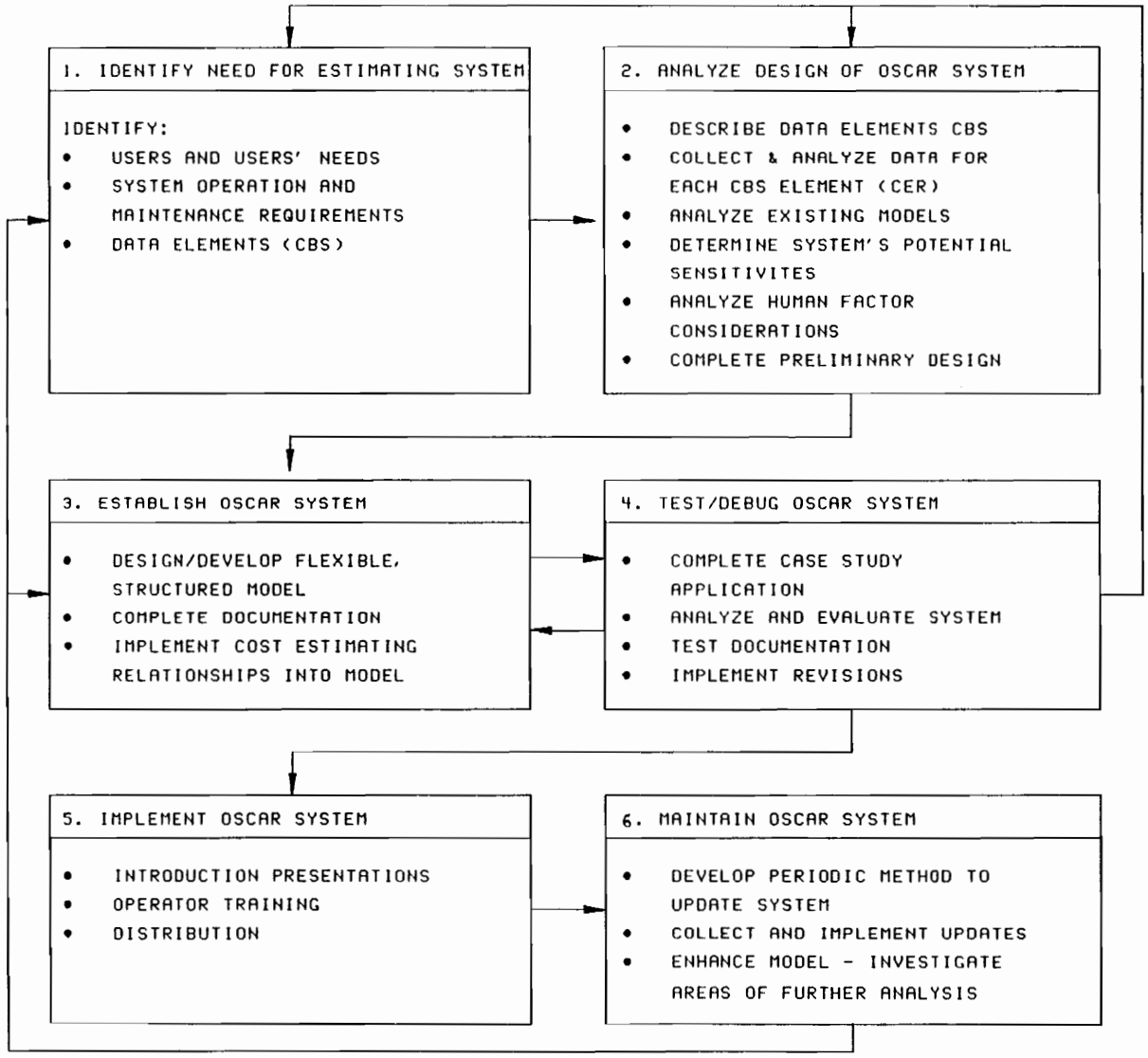


Figure 3 O&S Cost AnalyzeR (OSCAR) System Life-Cycle Process

cost estimating methodology. To accomplish this task it is necessary to interface with the users. The users can identify the inadequacies of the existing O&S cost estimating systems and the desired requirements for a new O&S cost estimating system. If it is determined that the deficiencies identified can be feasibly resolved, one must determine whether or not an existing O&S cost estimating system would fulfill this need.

Phase 2 is to analyze the OSCAR system's design requirements. This phase involves completing a detailed structured analysis so that a preliminary design can be completed. This involves gathering as much information as possible in order to define the elements of the OSCAR database and how they interact. This is accomplished by first defining an O&S Cost Breakdown Structure (CBS) for the missile system. Once the CBS is identified, it can be broken down into a lower level of detail to determine the parameters which affect the missile system's costs. In addition, the potential OSCAR model problem areas are investigated at this time in order to properly address them in the OSCAR model design. This involves analyzing the OSCAR model human factors' considerations and design sensitivities. Analyzing existing models to determine their pros and cons will aid in this process. Finally, a preliminary OSCAR system design can be completed.

Phase 3 is to establish an OSCAR system. This is completed by reviewing the analyses completed in phases 1 and 2 and implementing the preliminary OSCAR system design.

Phase 4 is to test and debug the OSCAR system. This involves determining what test procedures to use and how to analyze the data collected from these procedures. This will best be accomplished by

entering past history data from a missile system into the OSCAR model. The OSCAR model's predicted missile system O&S costs can then be compared to the actual O&S costs incurred. Note that any analytical testing of the OSCAR model also tests the validity of the OSCAR database. Not only does testing involve comparing the estimates to actuals but it also involves analyzing other important factors such as user friendliness, time, and completeness of documentation. Once the problems have been identified and hopefully resolved, phase 5 can begin.

Phase 5 is to implement the OSCAR system. This involves introducing the users to the OSCAR system and training the users in how to use the OSCAR system. In addition, a distribution channel is set up so that the OSCAR database and OSCAR model updates can be shared by all the users.

Phase 6 is the final and ongoing step in which the OSCAR system is maintained and updated. This step will provide the user with a missile system O&S cost estimating system which will continually fulfill their needs.

The proposed time frame to complete each of these phases is shown in Figure 4--**O&S Cost AnalyzeR** (OSCAR) System Life-Cycle Time Line. As shown by Figure 4, phases 1 through 3 and part of phase 4 have been completed as part of this project and report. It is planned to have phases 4 and 5 completed by the end of January 1992. Phase 6 will occur annually starting in January of 1993. For a further description of the tasks completed or to be completed for each of these phases, see the corresponding sections III through VIII of this report.

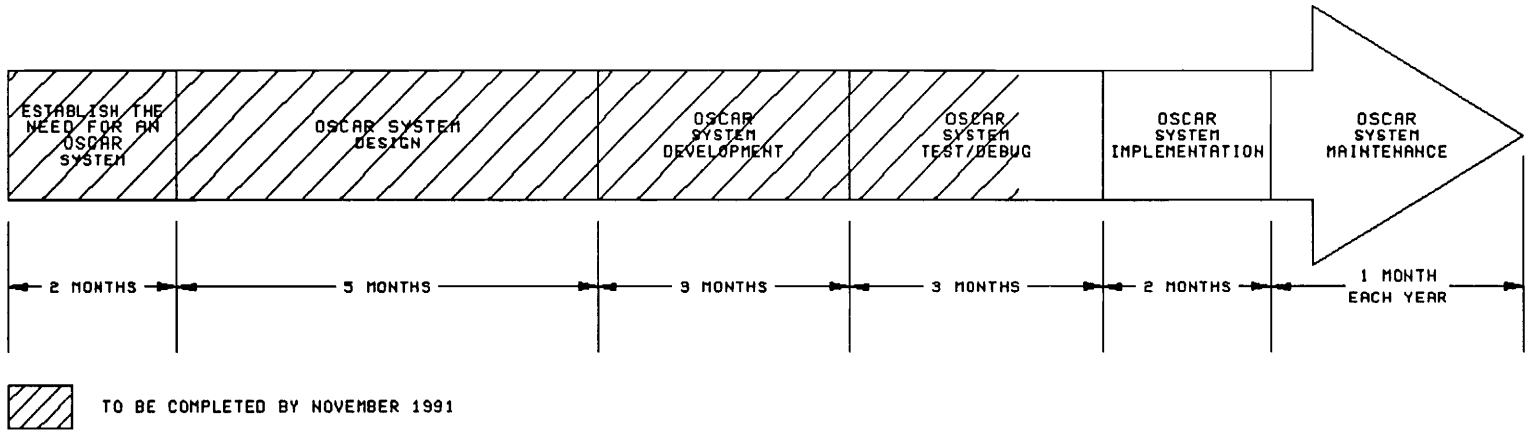


Figure 4 O&S Cost AnalyzeR (OSCAR) System Life-Cycle Time Line

II. Description of a Missile System

A. Mission Definition and Need

All weapon systems have a specific combat assignment which is based on a determined operational need. This combat assignment is normally referred to as a "mission". The mission is determined by threat changes, technology advancements, cost reduction, reliability improvements, or obsolescence of existing weapon systems.

As an example, the mission of the Multi-platform Advanced Cruise Missile (MAC) is to provide an all-weather, intermediate-range, anti-ship attack missile to be launched from aircraft, ship, and submarine platforms. It must be effective against surface combatants, patrol boats, merchant and fleet logistics ships, intelligence gathering vessels, and surfaced submarines. Of the existing weapon systems, the MAC missile is the only weapon system which can provide intermediate-range, stand-off, anti-ship capability in all weather, day, and night environments. Please note that both MAC and the examples used in this report are fictitious and are used for illustrative purposes only.

B. Performance Parameters

1. Performance parameters refer to the effectiveness of the operation or functioning of the missile system. For typical missile systems, operating characteristics include: launch platforms, target type, target mobility, target vulnerability, threat environment, missile altitude, missile velocity, missile range, missile size, missile

weight, and signature.

a.) Launch platforms include Aircraft (rail, ejection), Ship (vertical launch, rail (MK-13 Mod 4), torpedo tubes), and submarine (torpedo tubes, vertical launch system).

b.) Target characteristics include: target type (land-based, ship, submarine, and airborne), target mobility (stationary, moving), and target vulnerability (soft, moderate, and hard).

c.) Threat environments are defined as the types of countermeasures that a missile may have to overcome such as: infra-red jammer, decoys, and chaff.

d.) Missile signature includes the radar cross section (the projected size of the missile when being illuminated by radar), infra-red (amount of heat radiated by the missile), acoustic, and visual.

2. The performance parameters for the MAC missile include:

a.) Launch platforms - The capability to be launched from all platforms (aircraft, ships, and submarines) using a variety of launching systems;

b.) Target characteristics - The capability to intercept moderate target types including ships and surface submarines which will be moving at speeds in excess of 60 nautical miles per hour;

c.) Threat environment - The capability to penetrate threat environments including chaff, infra-red and optical jammer;

d.) Missile signature - The capability to maintain low visual observability while cruising in low altitudes;

e.) Miscellaneous - The capability to obtain a cruising velocity of Mach .5 with a maximum range capability of 50 miles. Missile diameter is 13.5 inches. Missile length is not to exceed 200 inches. Missile wing span is not to exceed 40 inches. The overall missile weight is not to exceed 1500 pounds. The warhead weight is not to exceed 500 pounds.

C. Use Requirements

Missile systems are in storage for the majority of their life. Air-launched missiles experience captive flights which range from one to two hours per flight. Besides flight test, missile deployment could occur during war time or some other global crisis. Deployment usage is less than 15 minutes from the initiation of the launch cycle through target detection and kill.

Missiles are tested (vibration, electrical, pressure) during scheduled and unscheduled maintenance. Maintenance usage per missile varies from 5 minutes to 12 hours per test.

D. Operational Deployment and Distribution

Missile operational deployment and distribution includes: 1) missile quantities procured, 2) specific platform capability requirements, 3) maintenance distribution locations, 4) transportation and material

handling requirements, 5) Material Support Date (MSD), and 6) subcontractor maintenance requirements. The purpose of identifying the operational deployment and distribution of missile systems is to aid in developing the maintenance concept. The following paragraphs will describe the MAC missile's deployment and distribution requirements.

1. There will be a total of 4,000 missile systems purchased with the first production delivery beginning in 1993 and continuing until 1998.

2. The missile system will be compatible with the following U.S. Navy ship and submarine classes: FF, DDG, CG/CG(N), DD-963, SSN, FFG-7, PHM. The missile system will be compatible with the following U.S. Navy aircraft types: P-3, S-3, A-7, and A-6. These ships, submarines, and aircraft will be located in strategic locations throughout the globe. The quantity of missiles on each platform will vary.

3. The missile will be handled between 15 support activities including: Fleet Activities/Corona, Metrology Engineering Center (MEC)/Metrology lab, Naval Air Engineering Center (NAEC)/Lakehurst, Naval Ordnance Center (NOS)/Indian Head, Naval Ships Systems Command (NSSC), Atlantic (LANT), NSSC, Pacific (PAC), Naval Ships Weapon Systems Engineering Station (NSWES)/Port Hueneme, Naval Underwater Systems Center (NUSC)/Newport, Naval Weapons Center (NWC)/China Lake, Naval Weapons Handling Center (NWHC)/Earle, NWS/Concord, NWS/Seal Beach, NWS/Fallbrook, NWS/Yorktown, and the Pacific Missile Test Center (PMTC)/Point Mugu. These facilities will be used by organizational level maintenance. The NWS (4) facilities are used for intermediate level maintenance which consist of refueling missiles, storage (during fleet overhaul), and scheduled/unscheduled maintenance. Spare parts for organizational and intermediate level maintenance will be

controlled by the program office until the MSD date. The MSD is the scheduled date for the transfer of responsibility of spare part replenishment from the contractor to the Ships Parts Control Center (SPCC). At that time spare parts will be controlled by the SPCC located in Philadelphia, Pennsylvania.

4. Depot maintenance will occur at the contractors facility which is located at Greensburg, Pennsylvania. It is planned to continue depot maintenance at the contractor facility throughout the life of the MAC missile. The depot level facility is responsible for repairing the guidance/control and propulsion sections of the missile. It is common for most missile programs to convert from a contractor or inorganic depot to a government or organic depot. For this transfer, a depot Navy Support Date (NSD) is determined. Once the depot is converted all ties (contracts - depot support) with the contractor are eliminated.

5. Transportation and Material handling considerations are required at the contractors facility, at the support activities, on the ships, submarines, and at the aircraft loading station. Missiles will be shipped in the outer shipping containers between the support activities and the fleet. Missile Weapon Replaceable Assembles (WRA) are typically shipped between the NWS support activities and the depot location. The following WRA's exist for this missile: guidance section, warhead section, sustainer section, and booster section. The primary mode of transportation will be highway movement by commercial flatbed trailer and airlift movement by military cargo aircraft or contract air cargo service. Secondary modes of transportation include helicopter, barge, or small craft.

6. There are 2 subcontractors which are responsible for maintenance or

replacement of 3 components including the engine, rocket motor, and warhead. These subcontractors are Chuck's Bionic Blasters and the Maximum Impact Corporation. Transportation will be required between the contractor and subcontractor facilities.

E. Operational Life Cycle

Like all military weapon systems, missile systems follow the acquisition cycle as defined in Department of Defense (DoD) Directives 5000.1[6]. It takes a typical missile system approximately 4 years before being approved for Engineering and Manufacturing Development. Engineering and Manufacturing Development and Production and Deployment could last 10 to 15 years. Then O&S for a typical missile system is usually identified as twenty years or weapon system obsolescence, whichever comes first. A typical missile life cycle is shown in Figure 5--The Acquisition Cycle[7]. As an example, the MAC missile system Production and Deployment and O&S phases of the life cycle are defined below.

1. Pilot production will began in 1991 with production beginning in 1992. Production will continue until the year 1997. During that time frame 4000 MAC systems will have been procured. The first production delivery will begin in 1993 and continue through 1998.

2. Maintenance facilities will begin operation in 1995 and continue through the twenty year anticipated lifetime of the missile system at which time the missile system will be disposed.

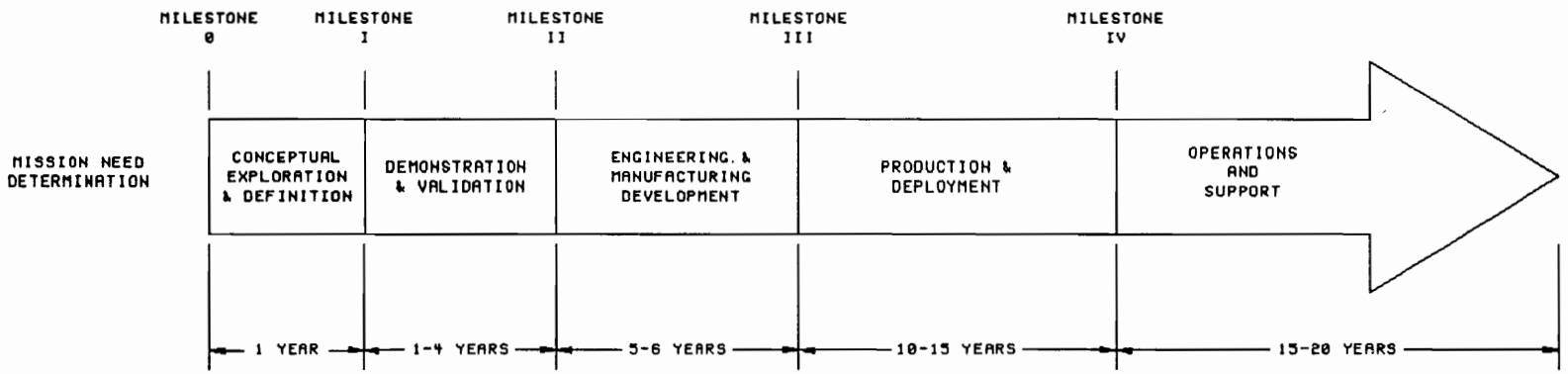


Figure 5 The Acquisition Cycle

F. Effectiveness Factors

Missile system effectiveness factors include reliability requirements and maintainability requirements. These factors are used during missile testing to ensure that the missile meets the intended mission objectives. The MAC effectiveness factors are described below as an example.

1. Missile Reliability Requirements:

a)

Status	Reliability Requirement
Boost	.9
Free Flight (Cruise)	.9
Dormant (Storage)	.9
Hit	.9
Mission Success	.65

Boost reliability is the probability of a missile successfully completing the boost segment of a flight. The reliability figure identified above indicates that in a sample population of missiles, 90% of the missiles will successfully complete the boost segment of the flight. Free flight or cruise reliability is the probability of a missile successfully completing the cruise segment of a flight. Dormant or storage reliability is the probability of a missile successfully operating after being in storage after some length of time (assuming that the missile was operating before it was placed in storage). Hit reliability is the probability of the missile hitting the target within the required circular area.

Mission success reliability is the product of the boost, free flight, dormant, and hit reliability. Therefore mission success reliability is the probability of success as a function of target detection, acquisition and destruction.

b.) Other reliability requirements include:

i) Reliability engineering and design which involves the predicting and updating of the mission profile reliability.

ii) Reliability production program which involves the contractor developing and maintaining a production component reliability program.

2. Missile Maintainability Requirements:

a) Organizational (fleet) level maintenance not to exceed .5 hours per Mean Corrective Maintenance Time (MCT). Thus for the maintenance repair tasks defined as organizational level, the total time to repair each maintenance item is not to exceed .5 hours. This incorporates the wooden round maintenance concept which is that a minimum/minimal amount of maintenance activity is to be completed at the organizational level.

b) Typically missile systems have 3 levels of maintenance consisting of organizational, intermediate, and depot. Some missile systems have only 2 levels of maintenance consisting of organizational and depot. For missile systems with only 2 levels of maintenance the depot level performs typical intermediate level maintenance activities, as well as, the typical depot level maintenance activities.

Organizational maintenance consists of only visual preventative maintenance, removal and replacement of wings, fins, cables, and missile system readiness verification using the Built-In-Test (BIT) capability. Low skill level is required and no special test or tooling is required at this level of maintenance.

c) Intermediate maintenance is performed during either: i) the scheduled maintenance periods denoted by the system-in-service-time (every four years for MAC), ii) when the missile fails its BIT, or iii) when the missile is damaged through handling. Intermediate maintenance consists of missile assembly and disassembly, replacement of unserviceable WRA sections with spare sections. A higher personnel skill level is required at intermediate maintenance. Tooling and test equipment is needed at this level of maintenance.

d) Depot level maintenance is to be performed when WRA assemblies fail intermediate maintenance. Depot consist of disassembly, detailed repair or replacement, modifications, and assembly. The highest amount of operator skill is required at this level of maintenance. Special tooling and test equipment is needed at this maintenance level.

e) Personnel tasks and efficiency factors - the Organizational maintenance personnel consist of torpedo-man mates and weapons technicians which require a very limited (low) amount of maintenance skill. Intermediate maintenance personnel require a moderate amount of maintenance skill. Depot maintenance personnel require a high maintenance skill level.

f) Training - Training courses for NWS and platform personnel will be accomplished using existing Navy training facilities.

g) Logistic Considerations - An Integrated Logistic Support Plan (ILSP) identifies and describes the methodology and management for logistic support of the missile.

G. Environment

Environmental considerations include those specified in MIL-STD 810[8] which are extreme values. The environmental conditions specified in MIL-STD 810 are for acceleration, vibration, shocks, temperature, altitude, moisture, sand and dust, and fungus. Exceptions to MIL-STD 810 can arise if the missile system is to be used in an environment other than that which is specified by the government as standard. Some examples of the MAC's environmental requirements include:

The missile will be stored in bunkers at the shore facilities and on associated ships and submarines. Thus the missile must be able to withstand exposure to salt water, heat to 2000 degrees Fahrenheit, cold to -75 degrees Fahrenheit, shock, vibration, and varying pressures. The missile must be able to withstand the pressure produced at a maximum altitude of 40,000 feet. The missile must be able to pass the Twenty-Eight-Day Humidity Test (moisture not to exceed 85% to pass) and the Blowing Rain Test.

H. Major Missile Components

Missile's can be divided into eight sections: airframe, guidance section, warhead, data link, flight control, fuze, propulsion, and telemetry (see Figure 6--Tactical-Missile Components and Figure 7--

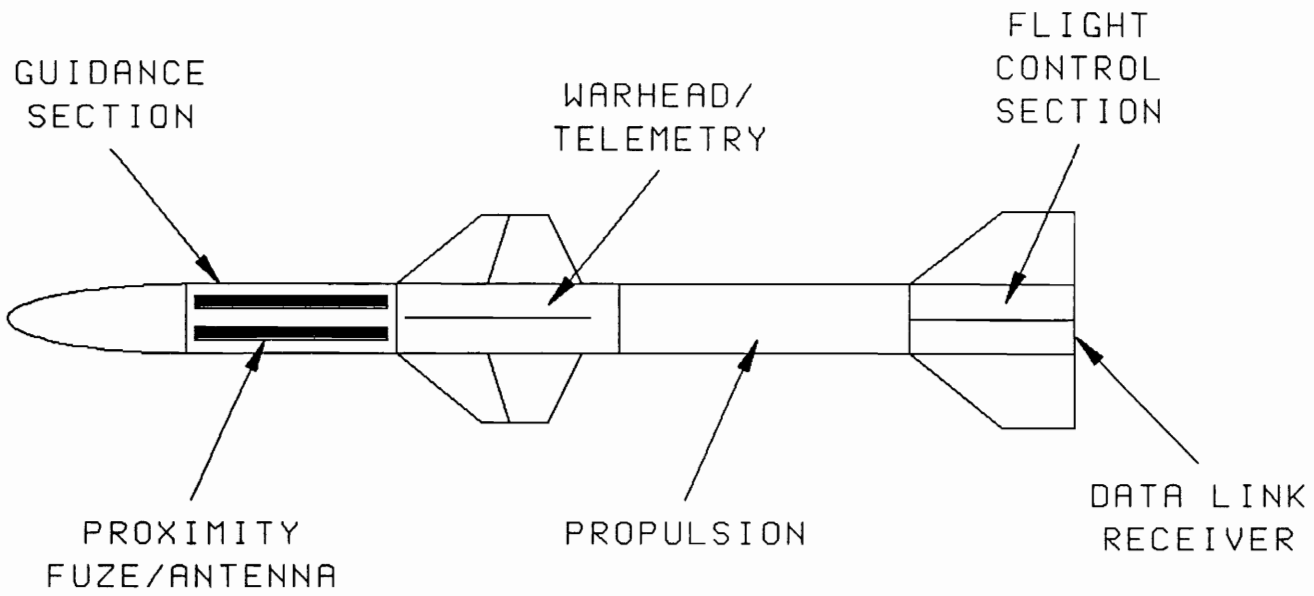


Figure 6 Tactical-Missile Components

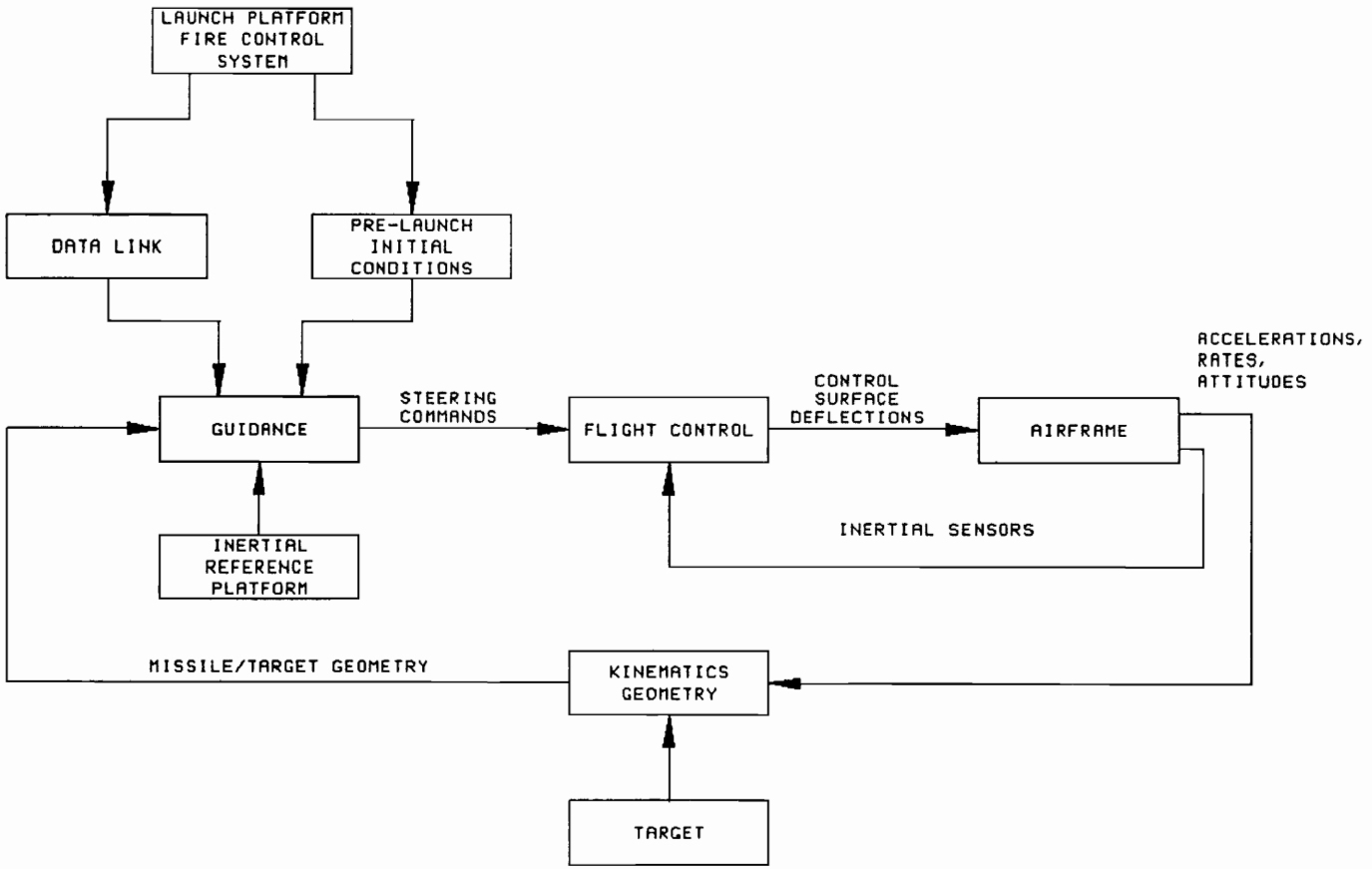


Figure 7 Tactical-Missile Functional Block Diagram

Tactical-Missile Functional Block Diagram[9]).

1. Airframe: Airframes vary in size, shape (round, rectangular), and material (steel and composite); however, all airframes function as a container which holds the missile components together. There are five different types of airframes which vary by the location of control surfaces (see Figure 8--Tactical-Missile Airframes[10]). Control surfaces provide the source of lift. These surfaces are canards, wings, and tails. These surfaces are controlled by actuators. The type of actuators used to control the missile surfaces include hydraulic, pneumatic, electro-mechanical, and thrust-vector.

2. Guidance Section: "The purpose of guidance section is to provide steering commands to the autopilot that will cause the missile to steer to and intercept the target."[11] Guidance is divided between a.) mid-course and b.) terminal.

a.) Mid-course guidance is required for medium (25-45 miles) and long-range (35+ miles) missiles.[12] Note that there is an overlap in range, of the definition of medium and long range missiles. Mid-course guidance is further broken down into i.) semi-active, ii.) inertial mid-course guidance, iii.) terrain comparison, and iv.) global positioning system.

i.) In semi-active guidance the platform's fire-control system illuminates the target.

ii.) "In inertial mid-course guidance, the missile is provided with the platform and target velocity and position data at launch. During flight an inertial reference system in the missile uses the initial

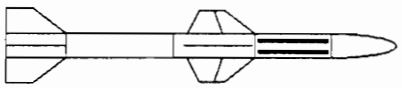
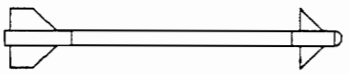
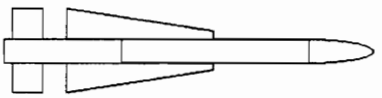
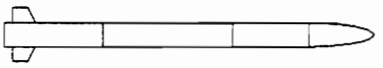
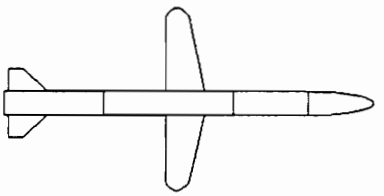
CRUCIFORM $B_L T_L W_{CL}$  BODY, TAIL LIFT; WING CONTROL	SPARROW AIM-7F AIM-7M/RIM-7M
CRUCIFORM $B_L T_L C_C$  BODY, TAIL LIFT;CANARD CONTROL	SIDEWINDER AIM-9L AIM-9M CHAPARRAL MIM-72 GBU-15 STINGER REDEYE MIM-43 RAM
CRUCIFORM $B_L W_L T_C$  BODY, WING LIFT; TAIL CONTROL	PHOENIX AIM-54A AIM-54C AMRAAM AIM-120A HARPOON AGM/RGM-84A STANDARD SM-2 MAVERICK AGM-65
CRUCIFORM $B_L T_C$  BODY LIFT; TAIL CONTROL	PATRIOT MIM-104
PLANFORM BANK-TO-TURN $B_L W_L T_C$  BODY,WING LIFT;TAIL CONTROL	TOMAHAWK

Figure 8 Tactical-Missile Airframe

conditions, the measured missile velocity and position during flight, and data-link updates from the fire-control system to compute the terminal acquisition parameters (target range, antenna direction, and target doppler)."[13]

iii.) In terrain comparison the radar altimeter produces terrain profiles along the missile system's route. These profiles are compared to stored reference maps in the guidance computer. Flight corrections are then made as required.

iv.) A global positioning system uses satellites to update the missiles position.

b.) Terminal guidance may be either: i.) semi-active, ii.) active, iii.) passive, iv.) spot tracking, v.) imaging electro-optical, and vi.) terrain comparison.

i.) A semi-active guidance system relies on the illuminator's fire-control system to provide the radar frequency illumination of the target.

ii) In an active guidance system, the missile has a transmitter which illuminates the target.

iii) A passive guidance system is one in which the radar frequencies emitted by the target are used for missile homing purposes.

iv) Spot tracking is an electro-optical guidance system which senses a "hot" spot on a target and uses this spot to guide the missile to the target.

v.) An imaging electro-optical guidance system creates an image of the target which is used for guidance.

vi) In terrain comparison the radar altimeter produces terrain profiles along the missile system's route.

More sophisticated missiles have inertial navigation systems and digital processing techniques that provide the missile more target parameters (range and acceleration) to improve guidance.

For example, the MAC guidance section consists of a coated plastic radome and an active radar seeker. Mid-course guidance is controlled by a 3-axis, strap down attitude reference assembly plus a general purpose digital computer and a short pulse radar altimeter. Targeting information can be automatically or manually inserted into the missiles guidance system prior to launch.

3. Warhead: The four types of warheads are: continuous rod, fragmentation, annular blast fragmentation, and the selectively aimable warhead. The continuous rod is designed to cut surface and structural members of the target. The fragmentation warhead is designed to propel numerous fragments outward in order to penetrate internal components of the target. The annular blast fragmentation warhead propels lightweight rods at the target; thus, attacking the structural members of the target. The aimable warhead has multiple detonators which penetrate and attack structural members of the target.

For example, the MAC warhead is a high explosive, blast type weighing 500 pounds. The warhead includes the penetration casing, a pressure probe, the safety/arming device, and a contact fuse with delay.

4. Data Link: "In semi-active guidance, the data link provides a transmission frequency reference and platform-to-missile doppler for doppler processing. In inertial mid-course guidance, the data link provides updates on target velocity and position."[14]

5. Flight Control: "The requirements of a flight control system are: to **stabilize** the airframe at the desired response for the planned operating conditions; provide maneuver **control**; and to generate the required missile accelerations to **steer** the missile to an intercept of the target."[15] The airframe motions about the x, y, and z axis are controlled through automatic-feedback control systems or autopilots. There are three different types of autopilots: lateral, roll, and bank-to-turn (see bibliography section under Eichblatt Jr. for more detail).

6. Fuze: The two types of fuzes are contact and proximity. The contact fuzes detonate when the missile makes physical contact with the target. The proximity fuze detonates when the missile passes close to the target.

7. Propulsion: The purpose of the propulsion section is to provide the missile with enough energy to enable the missile to reach it's designated target range. The phases of propulsion are boost (provide the missile with a high level of acceleration over a short period of time to enable the missile to quickly reach its desired velocity) and sustain (provide the missile with constant velocity during the flight). The three common types of missile propulsion are solid/liquid-propellant rocket motor, jet engine (turbojet and turbofan), and integrated rocket/ramjet. A turbofan engine is more efficient, complex, and expensive than a turbojet engine of the same size.

Integrated rocket/ramjet engines can cruise at an average of Mach 3; whereas, jet engines can cruise at an average of Mach .7.

For example, the MAC missile uses a solid-propellant rocket motor booster which contains a solid composite cast-in-cast propellant. At a predetermined altitude the relatively inexpensive expendable turbojet engine starts automatically and the flight path is undertaken. The turbojet provides 600 pounds of thrust, weighs 100 pounds, and has a shaft speed of 40,000 rpm.

8. Telemetry: Includes, "the complete measuring, transmitting, and receiving apparatus for remotely indicating, recording, and/or integrating information."[16]

For a more detailed breakout of missile components see MIL-STD-881B section C for the missile system Work Breakdown Structure[17].

I. Missile System's Life Cycle

The process used to recognize the need for a new weapon system (ie. missile system), and ultimately develop and deploy the weapon system is called the acquisition process. It is important to understand the various phases and milestones identified by the acquisition process starting with concept development and ending with weapon system disposal. Together the acquisition process phases and milestones form a weapon system life cycle.

The Acquisition Process consists of five phases and milestones (see Figure 9--Acquisition Milestones & Phases[18]). The acquisition process

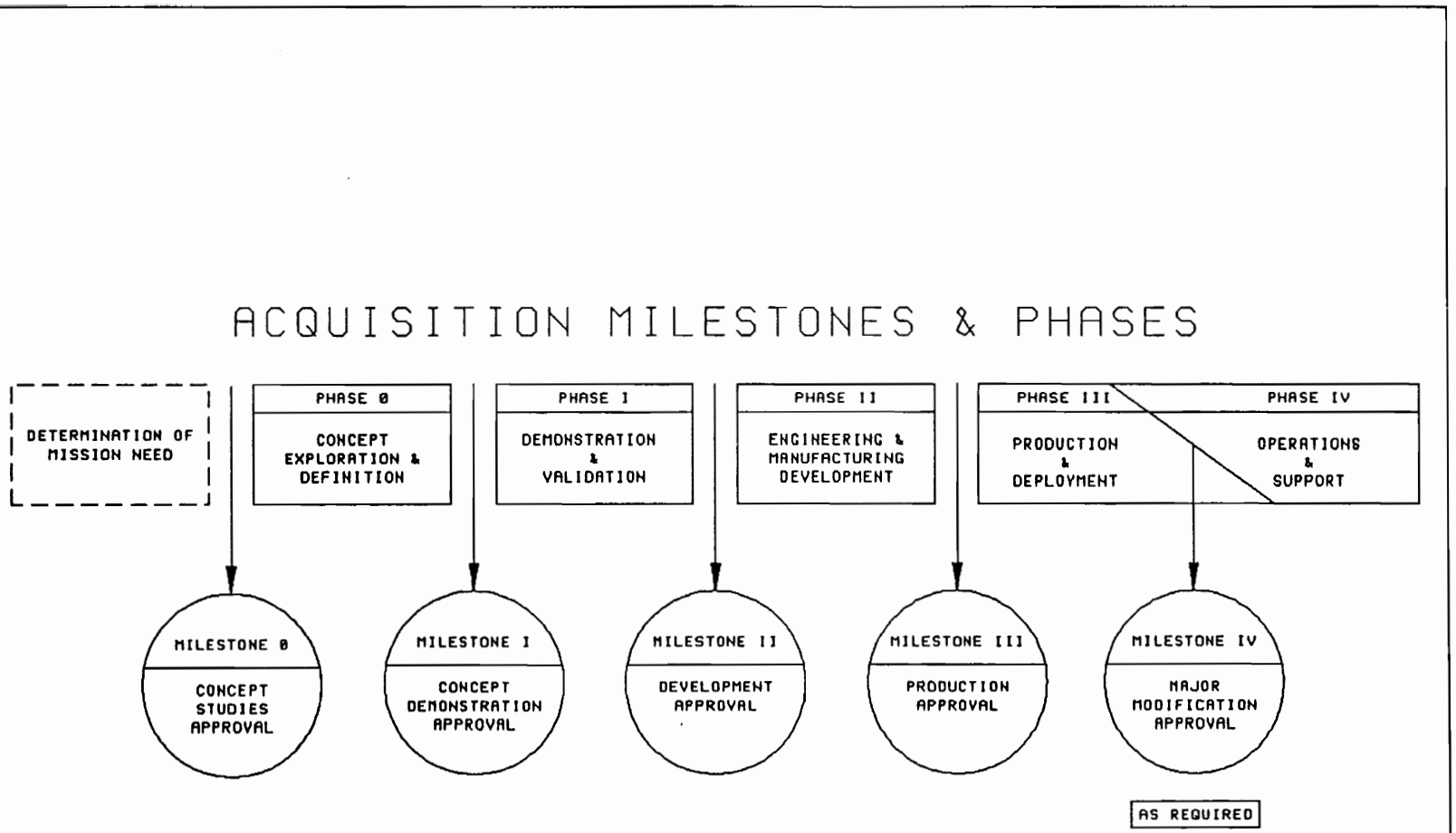


Figure 9 Acquisition Milestones & Phases

is an iterative process with many feedback loops as shown in Figure 10--Acquisition Phases and Milestone Decision Points[19] and Figure 11--The System Life-cycle Process[20]. As shown in Figure 10, the acquisition process is used to continually access the weapon system's cost, schedule, and performance risks. As shown in Figure 11, these risks are accessed through the use of feasibility studies, and other weapon system analysis techniques before continuing onto the next phase of the weapon system's life cycle. These decision points are called milestones.

Milestones are major decision points that separate the phases of an acquisition program. During Milestone 0, Concept Studies Approval, the mission need of the weapon system is analyzed. The review board determines if the mission need is: "based on a validated projected threat; cannot be satisfied by a nonmaterial solution; and is sufficiently important to continue on to Phase 0, Concept Exploration and Definition."[21] The product of this activity is the development of a Justification for Major System New Start (JMSNS). "The JMSNS defines the mission need, identifies constraints, and outlines the initial acquisition strategy".[22]

As a result of Milestone 0 approval the JMSNS is included in the service Program Objectives Memorandum (POM) and Phase 0 begins. During Phase 0, alternative concepts are investigated to determine if other feasible solutions exist. The development cycle of each project will begin with a minimum of two contractors/contractor teams performing concurrent but separate development.[23] System Analyses of the alternatives are conducted. Life cycle cost analyses, trade-off studies, performance, schedule and risks assessments are performed continuously for each alternative. Upon completion of Phase 0, a

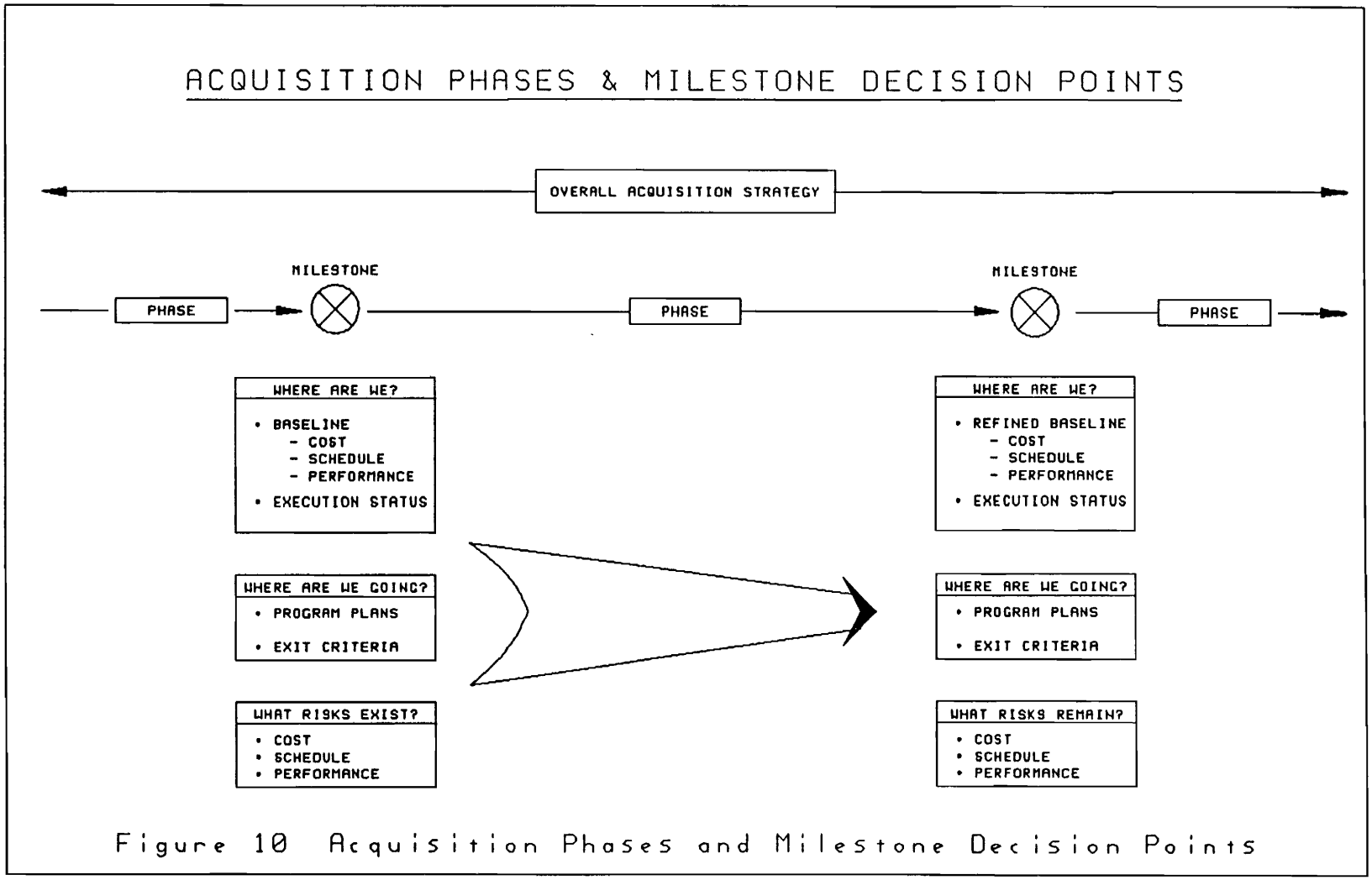


Figure 10 Acquisition Phases and Milestone Decision Points

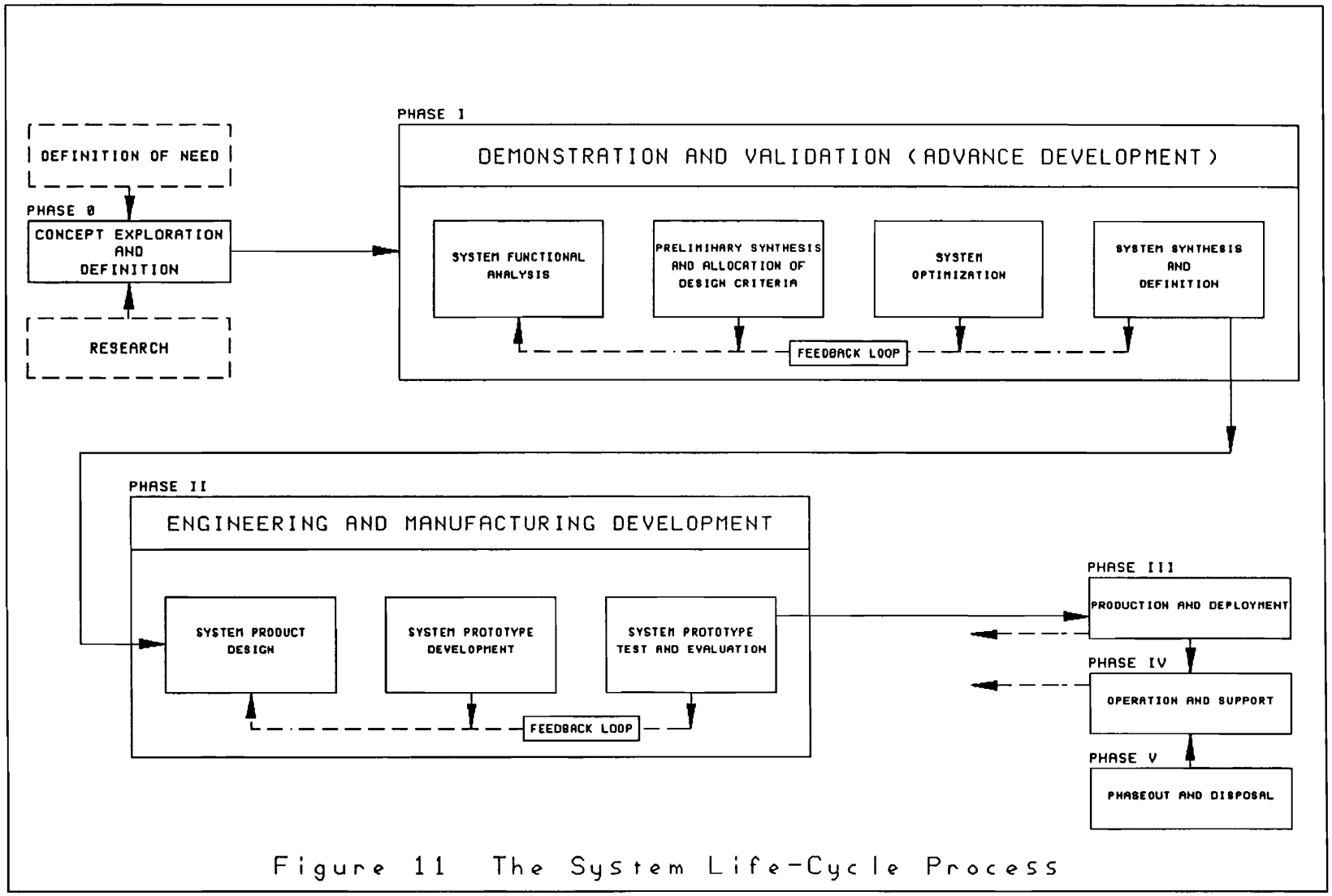


Figure 11 The System Life-Cycle Process

Milestone I, Concept Demonstration Approval review is conducted. Given that all the criteria from Milestone 0 are still valid, the following additional criteria are analyzed for approval of Milestone I for the most promising alternatives: "environmental concerns and mitigation measures have been identified; life cycle cost and annual funding requirements are affordable in the context of long range plans; and adequate resources (people and funds) to support the program are, or can become available".[24]

Approval of Milestone I marks the official beginning of an acquisition program or Phase 1, Demonstration and Validation. During this phase risk reduction and cost-capability trade-off efforts are completed for the major alternatives through a System Analysis approach. Competitive demonstrations are completed at which time two contractors are chosen to develop a weapon system to one design provided that a dual source strategy is appropriate.[25] The Under Secretary of Defense (Acquisition) will review the appropriateness of a dual source strategy during milestone reviews. Competitive Demonstrations will usually be in the form of a proposal which will enable the government contracting officials to determine if the competing contractors are capable of fulfilling the user's needs. Capability is measured both technically and operationally. Again a detailed analysis is conducted so that pros and cons of each of the competitors' proposal can be identified for review. A cost estimate of the Government's liability due to risk must be achieved prior to the next phase. Upon completion of Phase I, a Milestone II, Development Approval review is completed. Given all the criteria from Milestone 0 are still valid, the refinement of the Milestone I objectives (Development Baseline) are reviewed to decide if the program should be approved for continuation.

According SECNAV Instruction 4210, prior to the next phase the following must occur: "(1) The Chief of Naval Operations (CNO) or Commandant Marine Corps (CMC) shall certify that the results of cost-capability tradeoffs have been examined and that performance requirements that yield only marginal worth have been eliminated. (2) The competition Advocate General shall certify that the programs system's acquisition strategy provides for maximum effective, sustainable competition considering the unique nature of each acquisition. (3) The Specification Control Advocate General must certify that the development specification, including the contract data requirements list, have been reviewed and tailored to the operational requirements. (4) The Commander of the responsible Systems Command must certify that the proposed hardware/software development reflects maximum practical commonality."[26] Under certain circumstances there are exceptions to these criteria which must be approved by the Secretary of the Navy.

Upon approval of Milestone II, Phase II, Engineering and Manufacturing Development, begins. This phase initiates the design and low rate production of the weapon system. Testing of the selected alternatives are completed in it's intended operational and support environment to prove that the weapon system meets both operational and technical requirements. During this phase, various design reviews are held to review product, process, and material specifications to show that the weapon system is ready for full scale production and support. In addition, the prime and second source are chosen and second source qualification requirements are determined. Milestone III, Production Approval is reviewed. Given that all the criteria from Milestone 0 are still valid the refinements of the Milestone II objectives (Production Baseline) are reviewed to decide if the program should be approved for

continuation.

Upon approval of Milestone III, Phase III, Production and Deployment, begins. The purpose of the production phase is to deliver the specified end item at a reasonable cost. Early in the production phase true competition between the leader and the follower and the subcontractors begins. Follow on tests are performed and preparation for the operations and support phase are completed. Milestone IV, Major Modification Approval is reviewed (when modifications are required for other than emergencies or safety reasons) within this phase. "The objectives of Milestone IV is to determine if major upgrades to a weapon system currently in production are warranted and, for a weapon system where such action is warranted, establish an approved acquisition strategy and baseline for the program."[27]

The final Phase of the weapon system life cycle is Phase IV, Operations and Support. This phase overlaps the previous phase. As defined by the DOD Directive 5000.2 the O&S phase begins either when management responsibility is transferred from the developer to the maintainer or when the Initial Operational Capability (IOC) occurs.[28] The transfer of management responsibilities from the contractor to the maintainer occurs at the MSD date. MSD is the date when the responsibility of providing material to the support activities is transferred from the developer to the program support inventory control point (SPCC or Aviation Supply Office (ASO)). IOC is the attainment of the capability to effectively support a weapon system by the fleet. IOC dates vary by platform.

The purpose of the O&S phase is to "maintain" the weapon system in an operational manor once delivered to the fleet so that it performs as

required when deployed. This involves the introduction of product improvements and modifications as necessary to extend the weapon system's life. This also involves the process of transforming worn missiles into refurbished missiles. This Phase involves supporting the intermediate and depot activities with documentation, equipment, materials, and tools as required to maintain the weapon system throughout its operational life. The success of this phase is based on the effectiveness of the earlier phases of the weapon system. The final period of a missile system life cycle, also part of Phase IV, is missile system disposal.

In summary, "the acquisition of a weapon system begins with the development of a need and results in the procurement and support of a weapon system which fulfills these needs at an affordable cost. Thus the effort involved in the acquisition process can be modeled as input, process, and output. The input is the need and the other appropriate constraints. The process consists of managing the technical activities by establishing and maintaining a balance among cost, weapon system effectiveness, and schedule. The output is the weapon system."[29] Figures 10 and 11 identify these dynamic weapon system interfaces.

J. Operation and Support Phase

The purpose of the O&S phase is to "maintain" the weapon system in an operational manor once it is delivered to the fleet so that it performs as required when deployed. Thus, this phase of the weapon system's life cycle has a direct impact on fleet readiness and therefore directly affects National Security.

The O&S phase of the weapon system life cycle accounts for approximately 78% of the total dollars spent on a weapon system (see Figure 12--Program Life Cycle (Illustrative).[30] For these reasons, planning for this phase of a missile system's life cycle begins during missile system design. Planning involves determining manpower requirements, preventative maintenance plans, and the maintenance concept. Note: As shown by the diagram, there is an overlap in time, thus costs, between the production and the O&S phases of a missile system's life cycle.

The objective of this project report thus far has been to aid analysts in understanding the role that O&S plays in the missile system's life cycle. This objective has been achieved by first describing a generic missile system and by then describing a generic missile system's life-cycle. The second objective of this report is to develop a missile system O&S cost estimating system (OSCAR). The OSCAR system will provide analyst with a database, model, and methodology for collecting, estimating, and maintaining the OSCAR system. This will be completed by implementing the OSCAR system life-cycle process as defined by Figure 3.

As defined by Figure 3 the six step OSCAR system life-cycle process consists of:

1.) Identify the Need for the Cost Estimating Methodology
2.) Analyze the OSCAR System
3.) Establish the OSCAR System
4.) Test and Debug the OSCAR System
5.) Implement the OSCAR System
6.) Maintain the OSCAR System

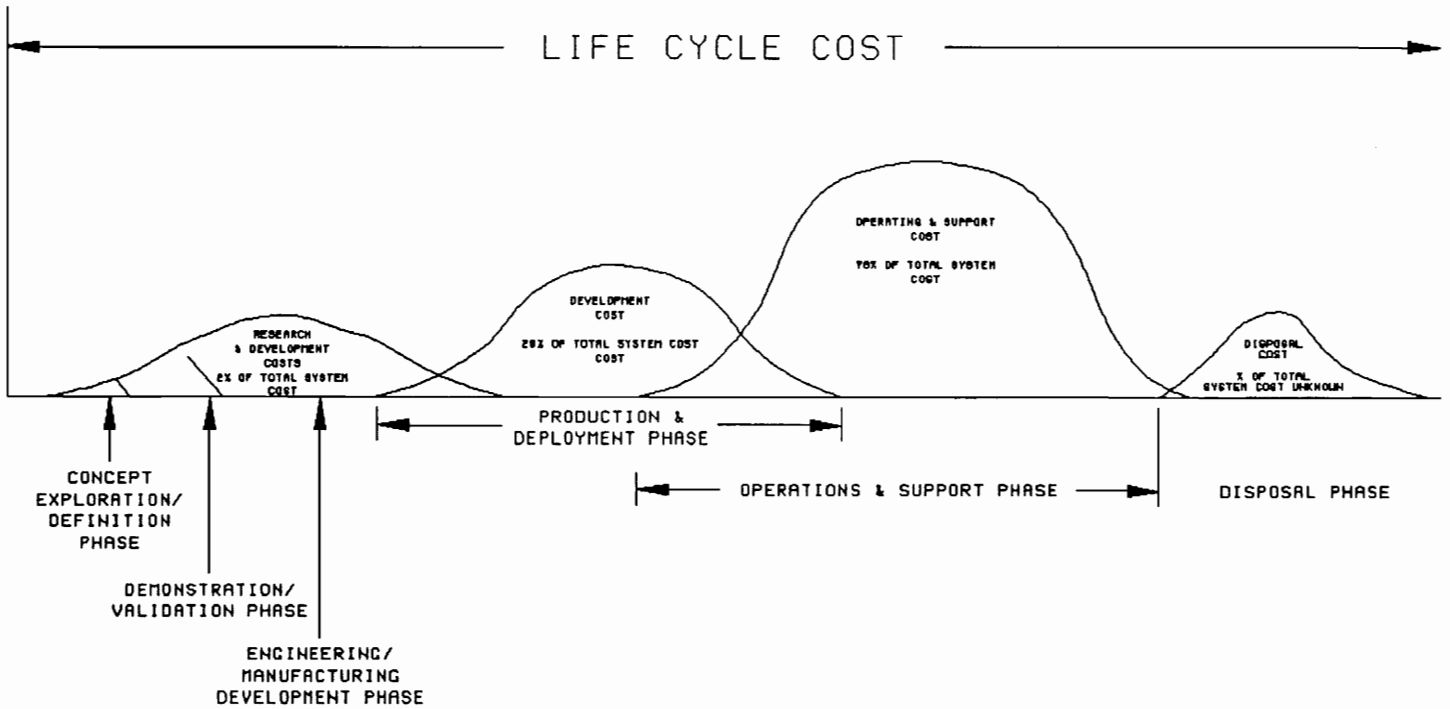


Figure 12 Program Life-Cycle (Illustrative)

The methodology implemented to complete each of the steps of the OSCAR system life-cycle process will be discussed in the sections to follow.

III. Need for the Cost Estimating Methodology

In an era in which budget shortfalls are commonplace, it is necessary for program sponsors to have an effective means of estimating and justifying their budgets. Program sponsors rely on cost analysts to complete and defend these detailed budget estimates. Since O&S accounts for approximately 78% of a weapons system's total cost, the importance of cost analysts having a structured means of estimating O&S costs is essential (see Figure 12).

Through discussions with personnel from the Naval Air Systems Command (NAVAIR) Cost Analysis (524) and Airborne Weapons Logistics (418) divisions the following O&S cost estimating system "deficiencies" were identified: 1) No central database which consolidated O&S CBS information existed. If a centralized database existed, the analysts would be able to use program history data to develop and support their estimates. 2) No Cost Estimating Relationships (CERs) for the CBS elements or sub-elements existed. This would also aid the analysts in developing and supporting cost estimates. CERs are analytically derived expressions relating costs to system (ie., missile, missile component) parameters. 3) No generic spreadsheet which could be used as a framework for completing O&S estimates existed (all Navy budgets submits required the same O&S CBS breakdown (Logistics Requirements and Funding Plan[31] (LRFP))). Having a standardized ready-made spreadsheet would save the analysts much time. 4) There is a division-wide interest in developing a cost estimating system. This cost estimating system would greatly aid the experienced analysts in developing and supporting budget estimates. In addition, new analysts would benefit by using the cost estimating system as a training aid.

The need for a cost estimating system exists. Figure 1--**O&S Cost AnalyzeR** (OSCAR) system defines the O&S cost estimating system identified as fulfilling the needs of the analysts. As shown by Figure 1, the OSCAR system requires defined methods of collecting, normalizing, and estimating the O&S information into the OSCAR database. As shown by Figure 1, it was decided that in addition to using a database, a "model" would be used to input, process, and output this data in a structured and organized manor. Also shown by the diagram, is the requirement for the OSCAR system to contain maintenance and enhancement procedures. The maintenance and enhancement of the OSCAR system will provide the users with an O&S cost estimating system which will continually fulfill their needs.

The following "requirements" for the OSCAR system were identified: 1) The use of a centralized database system so that all updates are available to all analysts; 2) The ability to enhance and continually update the database system; 3) The ability to use the model for all missile systems; 4) The ability for the user to understand the model's estimating methodology; 5) The ability to vary levels of maintenance, in the model, between 2 and 3 levels (Organizational and Depot verses Organizational, Intermediate, and Depot); 6) The ability to update the model's estimating parameters; 7) The ability to output different fiscal year dollars; 8) The ability to input a large number of delivery years into the model; 9) Model reports in the format of the LRFP CBS; 10) Model designed for user friendliness; and 11) Model default values where possible.

Neither NAVAIR 524 nor NAVAIR 418 has an O&S cost estimating system which is capable of these requirements. A need definitely exists. The requirements for this OSCAR system are feasible. A survey was

completed to insure that no O&S missile system database existed. To accomplish this effort the Cost Analysis Improvement Group (CAIG), Eglin and Wright Patterson Air Force Base, NAVAIR 524, and NAVAIR 418 were notified. Through telephone conversations it was determined that no O&S missile system database existed. Thus, since no O&S database existed, it was decided that one would be developed as part of this project.

Next a survey of the existing O&S cost models was completed to determine if a model existed which would fulfill the analysts' needs.

IV. OSCAR System Design

A. Existing Models

To complete a survey of the existing O&S cost models, a number of sources which publish this information were used: the RAND[32] studies, the Air Force Command Cost Estimating Manual[33], and other analysts[34]. A total of six models were investigated. The pros and cons of each of these models are explained in detail below.

1. Munitions Design Trade/Operation and Support Cost Model (MUNMOD)[35]: This model consists of three sections: the design trade model, the O&S cost estimating section, and the availability section.

a.) Pros:

i.) The cost estimating relationships used are logical. For example, the Poisson distribution spare parts routine 1-e^(-t/mtbf) is used to estimate the quantity of failures.

ii.) The model calculates maintenance and transportation costs.

iii.) The model is written in Fortran which is a powerful and flexible language.

iv.) The old version of the model was poorly documented; however, the new version is better documented.

b.) Cons:

i.) Maintenance and transportation are the only cost elements estimated.

ii.) The output is not in the proper LRFP format.

iii.) Input requirements are extremely detailed which may not be necessary. For example: 1) One must input the percent of total missiles to incur scheduled (recertification) and unscheduled maintenance each year. This requires a layout of the entire recertification schedule. Since missile schedules vary almost daily, this input must be recalculated every time the model is used.; 2) Missiles must be divided between four different environments. 3) Effectiveness factors for the flight line test equipment and intermediate level test equipment must be determined. 4) The number of operational flight tests per year must be determined for both organizational and intermediate level maintenance. 5) The intermediate level tests must be divided between the number of tests scheduled for each environment each year and the fraction of inventory that will be tested in each inspection interval in each environment.

iv.) Because of the detailed input required by this model, it is best suited for programs in later stages of their life cycle when more complete and valid statistical data for the missile is available.

v.) The existing version is on a mainframe. The IBM PC version is to be verified within the next 6 months. This model was originally programmed in 1977.

vi.) Since the model is written in fortran, an understanding of the fortran language is required to determine how a calculation is being applied.

vii.) The model is designed for Air-Launched missile s only. Therefore this model cannot be used for Harpoon, Standard, Slam, and the Tomahawk missiles.

viii.) The model is not easy to understand. This is due to the use of complicated equations in the design trade study and the effectiveness sections of the model. Perhaps this is why inputs are required in specific formats? For example, the number of new production deliveries for the year should be the average number of assets that will be in inventory for the entire year. What happens if the production deliveries are entered instead of the average number of production deliveries? Answers to these questions are not in the documentation.

2. McDonnell Douglas O&S model: This is an O&S model designed in-house by McDonnell Douglas to support in estimating costs.

a. Pros:

i.) Cost estimating relationships used are logical. For example, the Poisson distribution spare parts routine 1-e^(-t/mtbf) is used to estimate the quantity of failures.

ii.) The model is written in lotus 1-2-3 which is a powerful and flexible language. One can easily manipulate and change input.

iii.) The quantity of input questions are reasonable. The style of the

input questions are organized and easy to follow.

b. Cons:

i.) No documentation is available.

ii.) Except for input and output columns other columns are not labeled.

iii.) Information is proprietary so insight into the CERs are unavailable. For this same reason, no support data for the cost factors used are available. Thus, when multiple factors were used within a calculation, it could not be determined what the factors represented.

iv.) The model's output section showed the program's total cost instead of cost's for each individual year.

v.) The model does not calculate all of the O&S cost elements. This model only calculates maintenance, transportation, disposal, replacement training, data, and integrated logistics costs.

3. Weapons Budgeting Model (WBM)[36] missile version: This model calculates the O&S spare parts element only and is estimated for completion in the June 1992 time frame. This model is being designed specifically for the Logistics Missile s Division, NAVAIR 418. A similar model was provided to NAVAIR 412, the Logistics Aircraft s Division, within the past two years. The NAVAIR 412 aircraft model does not work for missile s.

4. Other models available are: Maverick Life Cycle Cost Model (MAVLCC)

and Operations and Support Cost Model (ONSCOSTS)[37]. MAVLCC was designed specifically for the Maverick missile. ONSCOSTS is not user friendly and requires precise input. Another model, the Navy AARES Model, was researched but has been recognized by NAVAIR as being obsolete. These models, although not directly applicable, were researched in detail.

This area of investigation is never complete since models are being established daily. Keeping abreast of existing models and their capabilities is an important part of the database enhancement process. Although models which are investigated may not fulfill every need, they should be used for ideas to build a new or improve an existing model. Specifically for this database effort, other models' CERs should be analyzed. However, the data which backs up a CER should be thoroughly examined and updated before using the CER.

In conclusion, since no existing model will support or could be modified to support the needs of the OSCAR system, it was decided that a "new" model (OSCAR) would be "developed" as part of this project.

B. OSCAR System Data Elements

As mentioned the LRFP CBS format will be used. The LRFP consist of nine logistics areas: 1.) 91x Maintenance, 2.) 92x Technical Data, 3.) 93x Supply Support, 4.) 94x Support & Test Equipment, 5.) 95x Computer Resources Support, 6.) 96x Facilities, 7.) 97x Training & Training Support, 8.) 98x ILS Program Management, and 9.) 99x Related Programs.[38] (Note: The program sponsor does not plan for or pay for missile disposal. A generic pot of money exists in which the Army

uses to dispose of Navy assets. Thus this element is not included in the LRFP.) Some of the nine LRFP elements will be broken down into level 4 of the CBS (see Table 1--O&S Cost Breakdown Structure). This CBS was constructed through researching the LRFP CBS elements currently being used by the Harpoon, Slam, Harm, Phoenix, Hellfire, Maverick, and Penguin missiles.

Comparisons of the LRFP CBS elements to Professor Blanchard's[39], Dean of System's Engineering at the Virginia Polytechnic Institute and State University, CBS elements are included in Appendix A--CBS Comparisons. As it is shown from the matrix in Appendix A, the relationship between Professor Blanchard's CBS and the LRFP CBS is not a clear cut "one for one" relationship. Most of the LRFP CBS elements map into a number of Professor Blanchard's CBS elements or vise versa. Remember that it was necessary to use the LRFP CBS as the database format because missile system history and program sponsor's budgets are planned for and tracked using the LRFP format.

To establish the OSCAR database, it was determined that costs would be collected and analyzed in the order of cost magnitude. It was determined that the maintenance, supply support, computer resources support, and related programs CBS elements accounted for 70-80%[40] [41] of the Tomahawk, Harpoon, Slam, Harm, Phoenix, Hellfire, Maverick, and Penguin missiles' O&S budget. Next, a list of the potential cost drivers of all of the CBS elements was established. Once this list was established it was possible to collect O&S missile system data for as many of the nine CBS categories identified above from as many missiles systems as possible with concentration on the major cost drivers (maintenance, supply support, software, and related programs). This was accomplished through personnel interviews and follow-up

Table 1: O&S Cost Breakdown Structure

Level #: 1	2	3	4	Time Frame:
91x	Maintenance			
	915	Intermediate Repair		
	915.1	Recertification		a
	915.2	Repair		
		915.21	Repair Labor	a
		915.22	Management SPCC	a
		915.23	Management ASO	a
	915.3	Non-Quantity Oriented Personnel		a
	915.4	Other		a
	915.5	Support and Test Equipment		a
	914	Depot Repair		
	914.1	Recertification		a
	914.2	Repair		a
	914.3	Support and Test Equipment		a
	917	Analysis/Studies, Plans, Data		a
	918	Other		a
92x	Technical Data			
	926	Technical Data Maintenance		
	926.1	Contractor Maintenance		a
	926.2	Government Maintenance		a
	927	Other		a
93x	Supply Support			
	932	Interim S&RP		
	932.1	Intermediate Replenishment (WPN)		a
	932.2	Depot Replenishment (WPN)		a
	933	Analysis/Studies, Plans, Data		a
	934	Other		a
94x	Support and Test Equipment			
	948	Contractor Sustaining Engineering		b
	949	Other		a
95x	Computer Resources Support			
	951	Software Maintenance		s
	952	Hardware Maintenance		s
	953	Other		a
96x	Facilities			
	967	Other		
	967.1	Intermediate Facility Maintenance		a
	967.2	Depot Facility Maintenance		a
97x	Training and Training Support			
	971	Training Course Instructors		a
	972	Training Devices/Aides		a
	975	Analysis, Studies, Plans, Data		a
	977	Other (Flight Test)		a

Table 1: O&S Cost Breakdown Structure (Cont.)

Level #: 1	2	3	4	1	2	3	4		Time Frame:
98x				ILS Program Management					
	981				Management				
		981.1				Government			a
		981.2				Contractor			a
		983				Plans			a
		984				Other			a
99x				Related Programs					
	991				Configuration Management				a
	992				Standardization				a
	993				Contractor Engineering Technical Serv				s
	994				Navy Engineering Technical Services				b
	995				Systems Effectiveness Engineering				a
	9911				Other				a
		9911.1				Retrofit			a
		9911.2				Transportation			
		9911.21				Intermediate Level			a
		9911.22				Depot Level			a
		9911.3				Other			a

conversations with the Tomahawk program office (Program Manager Air (PMA)-280), NAVAIR 418, Yorktown Naval Weapon Station, and SPCC. Once the cost information was collected, it was normalized and CERs were developed. The detailed cost data which supports the CERs that have been established are contained in the Operation and Support Cost AnalyzeR (OSCAR) Database[42] and will be discussed in Section V part D. This information was used to properly structure and support the OSCAR model.

The OSCAR database covers those program sponsored costs associated with O&S after the MSD date. Therefore interim spares and first destination transportation costs which are incurred before the MSD date are not included in the OSCAR database. However, replenishment spare parts and transportation after first destination are included in the OSCAR database. In addition, the Fleets' costs or organization level costs, except for those which the program sponsor pays for, are not covered by the OSCAR database. Since the CERs developed by the OSCAR database are incorporated into the OSCAR model, the same range of cost elements are contained in the OSCAR model as the OSCAR database.

In order for the OSCAR system to function effectively, it was decided that one centralized location will maintain the OSCAR system. This location is NAVAIR. All updates will be collected by NAVAIR whom will complete annual database documentation and model updates. The updated documentation (or revision bulletins) and model will then be distributed to each of the user facilities.

C. OSCAR Model User Considerations

The following information contains the Human Factors considerations dealing with the use and operation of the OSCAR model. In designing a model, the human operator interface must be considered and addressed. The optimum model usage will occur when the model is designed with the operator in mind. Human factor requirements are derived initially from the model's operational requirements and maintenance concept. The first step in establishing the human factor requirements is to identify the functions of the OSCAR model.

1. Functions

The following shows the main user functions of the OSCAR model:

a. Operate OSCAR Model - The main human interface of the model will be to collect input data, input data, print out reports, and verify reports.

b. Task - The tasks can be broken into data collection, data input by keyboard, printing reports by the printer, and verifying reports.

c. Sub-task - The major sub-tasks of the operator are: i) collecting data from field activities and management; ii) Turning on the computer and the printer; iii) Entering missile data; iv) Feeding paper into printer; v) Gathering reports from the printer; vi) Verifying input; vii) Collecting and transferring updated program history to a central file; viii) Keeping abreast of updates by reading the revision bulletins.

After analyzing the sub-tasks, two main human factor conditions must be addressed, Anthropometric Factors and Vision factors.

2. Anthropometric Factors

The OSCAR model will be located in the standard office environment. Thus a standard workstation will exist. Standard personal computers will be located at these workstations. The computers, keyboards, and chairs will have the ability to be adjusted as desired. The output will require a printer which can use 14X11 inch paper. The printers should be located in an area which provides the operator with easy access to the paper bin. The government mailing system will be used to gather and send updates to the centralized file which will be located at NAVAIR. Updates will be sent to the distribution list through revision bulletins. Files will be updated though use of the mailing system or in person.

3. Vision Factor

Since the computer screen does put a strain on the eyes, it is recommended that anti-glare screens be used to reduce eye strain. The workstation may require a desk top light if the surrounding area is not well lit.

D. OSCAR Model Design Sensitivities

During the modeling design process, an overview of the potential software design problem areas or design sensitive areas should be summarized and investigated. This will aid in effectively and

efficiently designing the OSCAR model. Typically, some of the "requirements" of the system can be considered design sensitive. The following overview will outline the design sensitive areas which needed to be considered while developing (programming) the OSCAR model. This outline will aid in the enhancement process by identifying those areas considered design sensitive. During the enhancement process, the list below should be updated as required. Please note that the OSCAR model was not limited by any of the design sensitive areas mentioned below. In fact, all of the model requirements mentioned below as design sensitive were successfully incorporated into the OSCAR model (see the Section V part B for further detail).

1. Lotus 1-2-3 was chosen as the software for this Personal Computer (PC) based model due to its flexibility and because of its popularity with the analysts. Since Lotus 1-2-3 will be used for this model (Version 2.1), the size of the model cannot exceed 1 megabyte of memory. This is Lotus 1-2-3's maximum capability. For convenience, it is planned to keep the model below 360,000 bytes or the memory size of a 5 1/2 inch floppy.

2. The maintenance and software section has the potential to be extremely large, the output from a separate model can be used as input to this section of the model if required.

3. The OSCAR model must be able to display O&S missile system's costs yearly. Most O&S costs begin with the first missile delivery year and end when the last missile is disposed of. To achieve this outlay, the model must be able to handle a flexible quantity of delivery years and a flexible quantity of years until missile system disposal. The maximum values are inputs of up to fifteen years of a delivery schedule

and up to twenty years of a missile system's life.

4. The OSCAR model must be designed so that a minimally trained analyst can update the model as required, annually.

5. The OSCAR model must have the output in the standard LRFP format. This requires a 7 year program outlay. Therefore, the model must be able to display any 7 years chosen by the analyst. In addition, the model must be able to display the missile system's O&S budget for the life of the missile system.

6. Since program schedules change frequently, the OSCAR model must be able to calculate the recertification schedule automatically. In addition, the OSCAR model must be able to accept manual schedule inputs. This is useful for programs which are more mature and for "what if?" drills.

7. Additional areas in which the OSCAR model may have to be sensitive to are: missile system environments, organic verses inorganic depot maintenance facilities, model enhancements, major retrofits (out of scope program retrofits), and software maintenance. These areas are discussed in Section XII of this report. The model must be designed to take these potential sensitivities into consideration.

V. OSCAR System Development

A. OSCAR Model Capability

The "new" model, OSCAR, which has been designed specifically for this OSCAR system has been customized to estimate O&S cost requirements of any missile system. Specifically, the OSCAR model will estimate those costs associated with missile system's support after first destination transportation and after the MSD has occurred. Thus the OSCAR model will estimate replenishment spares and secondary destination transportation costs. The OSCAR model will estimate the program sponsor's costs only (ie. fleet costs will not be provided by this model).

In addition to using the OSCAR model for budget estimates, this model can be used to evaluate O&S contractor proposal evaluations. The input file can be used as the O&S portion of the cost instructions submitted to contractors in the Request for Proposal (RFP). The analyst can input this information into the model and have a detailed estimate of the O&S missile system's costs.

B. OSCAR Model Characteristics

The information to follow provides a brief explanation of the OSCAR Model's characteristics:

1. The OSCAR model is a newly developed state-of-the-art model designed to estimate any missile system's O&S costs.

2. The OSCAR model covers all O&S cost elements.

3. The OSCAR model estimates two or three levels of maintenance. The detailed output spreadsheet divides each cost category into intermediate and depot level. Organizational level costs were excluded.

4. The output can be requested in constant FY91 dollars or then year dollars. All input must be in the base year FY91 dollars. Escalation figures entered must use base year FY91 dollars because all of the CERs are in FY91 dollars. The escalation defaults are the Operations and Maintenance, Navy (O&M,N) and Weapon Procurement, Navy (WPN), base year: MID-FY 1991, budget year multiplier indices, prepared by the Naval Center for Cost Analysis, February 1991.[43] If a different constant year is required, this can be accomplished by completing the following: a.) changing the base year of the CERs from FY91 to the preferred constant year FYxx (base year MID-FYxx) dollars; b.) changing the escalation figures from base year FY91 to the preferred base year FYxx dollars; c.) changing the first year of delivery to the preferred base year FYxx; d.) changing all inputs to the preferred base year FYxx dollars.

5. The OSCAR model calculates the recertification schedule automatically based on the delivery schedule provided, System-In-Service-Time (SIST), etc. This function can be overridden by the use of a "manual schedule" provided by the analyst.

6. The OSCAR model provides an automatic recertification schedule based on input ranging from one to fifteen years of deliveries.

7. The OSCAR model provides detailed or summary LRFP formatted outputs.

8. The OSCAR model will show the LRFP starting in the year specified and continuing seven years outward. Thus, different years can be displayed in the LRFP format.

9. The OSCAR model calculates up to twenty years of missile usage. Any usage period ranging from one to twenty years can be put into the model.

10. The OSCAR model contains default values for various line items.

11. An error statement occurs or default values are used for illogical input.

12. Approved "funded" budget figures can be manually entered into the LRFP output section. This enables the analyst to compare funded budget figures to the requirements estimated by the model.

C. OSCAR Model Operation

The analyst must enter answers to the input questions. All dollars must be entered in Base Year FY 1991 dollars. All dollars entered into the model are to be in thousands and loaded (including Overhead, General and Administrative, Facility Capital Cost of Money, and Profit). Based on the calculated or manual recertification schedule the OSCAR model determines the yearly cost of maintenance required through a detailed LRFP format. The analyst can run various iterations

by changing answers to input questions (testing for sensitiveness, etc).

1. Model Sections:

a.) Input (see last Figure 13--OSCAR Model Format)

Input consists of a list of 114 questions. This section is divided into the LRFP categories. The LRFP categories are: 1.) 91x Maintenance, 2.) 92x Technical Data, 3.) 93x Supply Support, 4.) 94x Support & Test Equipment, 5.) 95x Computer Resources Support, 6.) 96x Facilities, 7.) 97x Training & Training Support, 8.) 98x ILS Program Management, and 9.) 99x Related Programs (see Appendix B--Input).

b.) Output consists of a summary LRFP for both O&M,N and WPN costs. See Appendix C--LRFP Output. The model does not escalate manual budget inputs to the output files. Therefore, these manual inputs must be in constant FY91$ or escalated (depending on what type of dollars the output is requested in).

c.) Schedule consists of four options (see Appendix D--Schedule):

Three - recertification occurring every 3 years (SIST =3).
Four - recertification occurring every 4 years (SIST =4).
Five - recertification occurring every 5 years (SIST =5).
Manual - recertification occurring as manually provided.

d.) Detail consists of costs associated with the lower level CBS LRFP elements (see Appendix E--Detail Output).

e.) Factors consists of those factors used for the CERs that are not

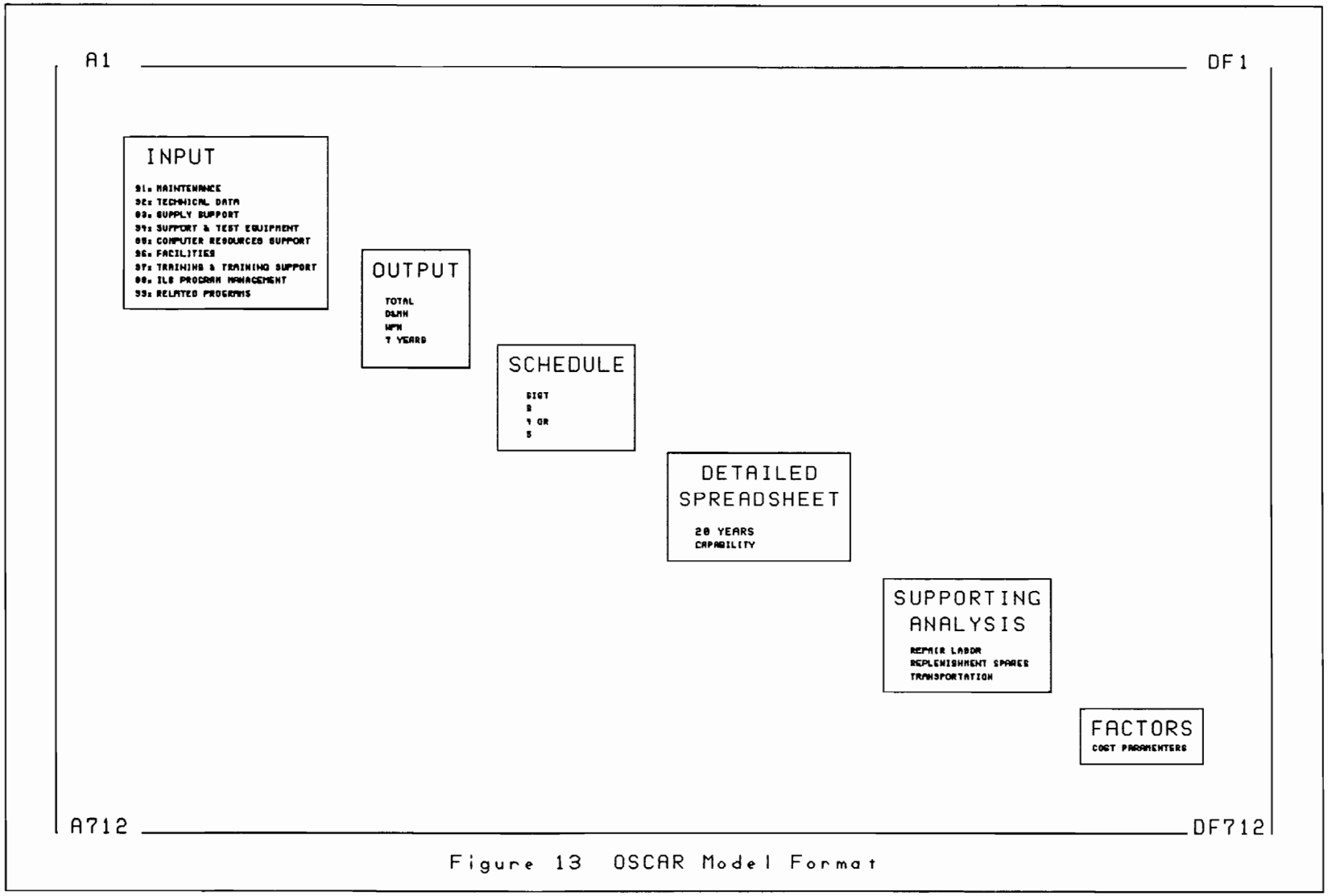


Figure 13 OSCAR Model Format

contained in the input section (see Appendix F--Factors).

f.) Repairs consists of the detailed analyses performed based on the input data (see Appendix G--Repair).

g.) Transportation consists of the detailed analyses performed based on the input data (see Appendix G--Transportation).

h.) Replenishment requirements consists of the detailed analyses performed based on the input data (see Appendix G--Replenishment).

2. Menu:

The menu consists of the following commands:

a.) INPUT - Displays Input Section
b.) OUTPUT - Displays Output Section
c.) MANUAL - Displays Manual Schedule Section
d.) UPDATE - Updates File
e.) SAVE - Saves File
f.) DPRINT - Prints Input, LRFP, Detail, and Factors
g.) PRINT - Prints Input and LRFP Format
h.) EXIT - Returns to Lotus Functions

The menu is displayed in the upper left hand corner of the screen. The menu is initially displayed when the file named "OSCAR" is retrieved. The menu is then displayed anytime the ALT M keys are pressed in sequence. Menu items can be selected by pressing the initial character or by highlighting the command and pressing the RETURN key. The program then continues execution of the chosen command. If the ESCAPE

key is pressed while in the menu, the menu will disappear from view and the curser will remain at the last cell addressed in the file. The following is a brief description of each menu command:

a.) INPUT - This command allows the user to view the input screen. The user should input the values requested and save the file prior to exiting Lotus.

b.) OUTPUT - This command allows the user to view the output screen. The user should input O&M,N and WPN budgeted figures and save the file prior to exiting Lotus.

c.) MANUAL - This command allows the user to view the manual screen. The user should input the manual recertification schedule which includes attrition considerations and save the file prior to exiting Lotus.

d.) UPDATE - This command updates the file based on the information in the input section of the file. (Note: A couple of subroutines are initiated by use of this command. For example, the recertification schedule and calculations are updated by this command. Thus, a simple "F9" will not update a file.)

e.) SAVE - This command initiates a file save. During the pause, the user is prompted to enter the floppy drive and filename to save (ie. a:OS). Push enter and the file will be saved. (Note: one file requires approximately 250 bytes of memory). You should not use the original file name.

f.) DPRINT - This command prints the input, LRFP outputs (O&M,N and

WPN), detail, and factor reports. (Note: Remember to "UPDATE" before printing.)

g.) PRINT - This command prints the input, and LRFP outputs (O&M,N and WPN) reports. (Note: Remember to "UPDATE" before printing.)

h.) EXIT - This option brings the user back to the Lotus functions. (Note: This command does not save the file).

3. Operation Detail:

a.) Executing the OSCAR model: Using the Lotus 1-2-3 software, get into the worksheet screen (the blank screen which appears once Lotus has been loaded). Using the Lotus commands press "/" "FILE" "RETRIEVE" "A:OSCAR" enter. After the brief introduction screen, the user is prompted to press return. Like the "Lotus menu" an "OSCAR menu" appears at the top left hand corner of the screen (see menu for description of commands). The user should then choose a command either by entering the first letter of the command or by moving the curser over the command (highlighting the command) and pressing enter (just like using the "Lotus menu"). After the command is chosen the corresponding menu screen or action is initiated. Notice that a brief description of each command appears underneath the command when the curser is placed over the command. To return to the "OSCAR menu" at anytime press "ALT M" in sequence. To exit the "OSCAR menu" press "ESC".

b.) To save a file, either use the OSCAR menu command "SAVE" or simply press "\","FILE", "SAVE", "enter".

c.) To exit screens, either use the OSCAR menu command "EXIT" or "/" "QUIT". This will bring the user back to the Lotus functions (remember to save the input before exiting).

4. Other:

a.) the OSCAR model is protected and only certain columns and rows of the file are available to the user.

b.) Users can use the OSCAR menu command or use GOTO "Manual" or GOTO "OUTPUT" or GOTO "OUTWPN" to include manual input when required. All other cells are protected.

5. Model CBS Time Frames

There are two major time frames when costs for each CBS element occurs. Each of these time frames and the logic used to program these time frames will be described below for each of the CBS elements.

a.) If the sub-category costs occur when the recertification occurs, the following logic statement is used: @if recertification quantity > 0, then calculate, otherwise zero.

b.) When the sub-category costs start during the year of the first missile delivery and ends at the end of the program then the following logic statement was incorporated: @if (the column year < the first production lot year + sist + 1 #or# recertification quantity > 0), then calculate, otherwise zero.

The time frame for each of the CBS elements are shown in table one.

The letter "a" and "b" refer to the above time frame definitions. The letter "s" signifies time frames other than the above 2, the corresponding time frames for "s" are described below.

Software Maint	Begins when production stops and ends at the end of the program.
Contr Engr Technical Serv	Option: Either disappears when production ends or at the end of the program. (dependent on the answer to the corresponding input question)

D. OSCAR System Estimating Methodology

Appendix H--Methodology contains the CBS elements' methodology used in the OSCAR model. Those CBS elements which are listed at the end of Appendix H do not have an associated CER assigned to them since they are input values as specified by the analyst. For example, all "other" and "data" CBS costs are based on the "dollars per year" entered by the analyst. The majority of the CERs were statistically derived from the data collected from the different missile systems.

The OSCAR Database[44] contains detailed cost data which supports the CERs developed and additional information on data sources and on how to normalize the data. All CERs are in FY91 dollars.

1. The CERs shown for repair labor, repair material, and transportation costs for both intermediate and depot level (CBS numbers 915.22, 914.2, 932.1, 932.2, 9911.21, and 9911.22) require additional

documentation to explain how these costs are derived. The input sections for these categories contain default values based on other missile programs' past history. In addition, this history has been provided to the analysts who can in turn use the history as input values. Data for the following missile systems are included: Harpoon, Harm, Hellfire, Maverick, Shrike, Sidearm, Sidewinder, Skipper, Slam, Sparrow, Phoenix, and Walleye. Note: User inputs to the number of levels of maintenance affects the total costs associated with each of these CBS elements (see Appendix H).

a.) 915.22 and 914.2 are intermediate and depot level repair. These costs are calculated based on the user inputs or default values to missile component failure rates and associated component repair costs. The component sections identified by the model are: guidance and control, propulsion, warhead, wings and fins, and container. Repair dollars per missile are estimated for each component by multiplying the component repair percentage by the component labor dollars per repair. Based on the number of levels of maintenance, the corresponding intermediate or depot level incurs these component repair costs. The individual intermediate and depot level component repair costs are multiplied by the total quantity of scheduled and unscheduled missiles for each year. This equals the corresponding total intermediate and depot level maintenance repair dollars per year.

b.) 932.1 and 932.2 are intermediate and depot level replenishment supply costs (always WPN). These costs are calculated based on the user inputs or default values to missile component scrap rates and associated component investment costs. The component sections identified by the model are: guidance and control, propulsion, warhead, wings and fins, and container. Replenishment spares' dollars

per missile are estimated for each component by multiplying the component scrap percentage by the component investment dollars. Based on the number of levels of maintenance, the corresponding intermediate or depot level incurs these component replenishment costs. The individual intermediate and depot level component replenishment costs are multiplied by the total quantity of scheduled and unscheduled missiles for each year. This equals the corresponding total intermediate and depot level supply replenishment dollars per year.

c.) 9911.21, and 9911.22 are intermediate and depot level transportation costs. Transportation for missile components are required to and from the intermediate, depot, and subcontractor facilities. These costs are calculated based on the user inputs to missile component weight and percent failure (default value available). The component sections identified by the model are: guidance and control, propulsion, warhead, wings and fins, and container. Transportation dollars per missile are estimated for each component by multiplying the component failure percentage by the component weight. Based on the number of levels of maintenance, the corresponding intermediate or depot level incurs these component transportation costs. The individual intermediate and depot level component transportation costs are multiplied by the total quantity of scheduled and unscheduled missiles for each year. This equals the corresponding total intermediate and depot level transportation dollars per year.

2.) Descriptions of each of the CBS elements are identified in the LRFP documentation. A brief description of those elements not sufficiently defined in the LRFP will be described below.

a.) 915.1 and 914.1, recertification: This CBS element includes those

costs associated with the 100% inspection of the missile, as well as, the replacement of the WRA. (All repair costs are covered under 915.21 and 914.2).

b.) 915.3, intermediate level non-quantity oriented personnel: This CBS element is associated with such intermediate level activities as: hands on test set maintenance, planning, material handling, toolroom manager, supply support manager, ancillary equipment, and supply host and tenant. These personnel are located at the intermediate level facilities.

c.) 915.4, intermediate level other: This includes the intermediate level activities dealing with quality control labor and sample labor. These personnel are located at the intermediate level facilities.

d.) 915.5 & 914.3, intermediate and depot level maintenance support and test equipment: This includes intermediate level hands on maintenance of equipment (including training equipment) other than the test set maintenance. For an inorganic (contractor) depot maintenance facility, these costs are usually covered in the overhead. If the support and test equipment maintenance is included in the overhead, these costs will be located in the corresponding intermediate or depot level maintenance categories of recertification and repair.

e.) 926.1 and 926.2, contractor and government technical data maintenance: These elements include technical manual maintenance (ie. changes, updates, printing, distribution).

f.) 934, supply support: This element includes labor and material associated with supply, analysis, plans, data. The CBS categories of

"other" and "analysis, plans, and data" contain missile specific costs except for CBS 934. CBS 934 includes the maintenance of a management system. These costs are shared by all of NAVAIR's missile programs. The purpose of this management system, is to aid the missile programs with supply support models and tools.

g.) 948, contractor sustaining engineering: This element includes the labor associated with the engineers located at the depot facilities who support hardware, software, test and support equipment maintenance. These engineers aid in fleet software support and serve as the experts who analyze equipment maintenance plans and part failure analyses.

h.) 951 and 952, software and hardware computer support: These elements include government personnel who support computer related maintenance activities (documentation, etc.).

i.) 981.1 and 981.2, government and contractor Integrated Logistic Support (ILS): These elements include the managers of the government and contractor engineers.

j.) 991, Configuration management: This element includes government personnel located at the cognizant field activity.

k.) 992, Standardization: This element includes government personnel which complete standardization analyses.

l.) 993, contractor engineering technical services support: This element includes the government personnel on-site with test set maintenance, etc. These personnel are hands on engineers who usually are user replaced after the last production lot by government

personnel, CBS #994.

m.) 994, navy engineering technical services support: These services are provided by the government personnel on-site which complete test set maintenance, etc.

n.) 995, system effectiveness engineering: This element includes government personnel which complete missile system effectiveness analyses and projects.

o.) 9911.1, retrofit (always WPN): This element includes the in-scope missile system modifications. These minor modifications could be required for safety, etc. Minor modifications are identified on a separate LRFP for the missile system.

3.) A normal distribution was assumed for the following CBS elements: intermediate and depot level recertification and repair (components failure rates and hours per repair), and support labor (NQO) hours. This is a valid assumption since the values of these measurements should fall within a symmetric pattern about a central value or mean. For each of these elements, a standard deviation of plus 3 was added to the mean value to obtain a 99.7% probability of being within the maximum range of the CBS element's cost. This is in line with the conservative approach which is usually taken for budget estimating.

4. Other - The recertification schedule calculated by the model takes attrition into consideration. This attrition value is entered by the analyst.

VI. OSCAR System Test/Debug

A. Case Study Application

Testing and debugging of software programs are usually performed in the order of alpha, Verification and Validation (V&V), and beta testing. Alpha testing is defined as the developer verifying and validating the program in a laboratory environment. Verification and validation testing is defined as an independent test agent performing testing and debugging on the software in a laboratory environment. An independent test agent is a person other than the system developer and the system customer. A system V&V is usually completed before the software is released to the user. Beta testing is defined as having a number of users testing the software in the users' environment and reporting problems to the developer. Variations of this testing and debugging process are common due to specific customers' needs, budget constraints, etc. The testing of the OSCAR system model includes a variation which will be mentioned later in this section. Note that any analytical testing of the OSCAR model also tests the validity the OSCAR database. Therefore if any analytical problems are found with the OSCAR model, both the OSCAR model and database will be analyzed and corrected if necessary.

For the OSCAR model, a bottoms-up testing approach was completed for alpha testing and will be completed for V&V testing. Five stages are identified in this testing approach. The five stages are: 1.) unit, 2.) module, 3.) subsystem , 4.) integration, and 5.) acceptance testing.[45]

1. Unit testing is the testing of individual stand-alone components. For the OSCAR model, an example of unit testing was the testing of the "schedule", "repair", "input", and "factors" sections of the model.

2. Module testing is completed after each program unit is tested. Module testing is the testing of the interdependent units which interact within a module. For the OSCAR model, an example of module testing was the testing of the "detail" section where the "schedule", "factors", and "input" sections are units which affect this module.

3. Model subsystem testing is completed after module testing. Subsystem testing is the testing of the interdependent modules which interact within a subsystem. Testing for correct "escalation" calculations involved the combined testing of the modules of "detail" and "output" and the unit of "input".

4. Integration testing is the testing of the interfaces between the subsystems, modules, and units of the model. As shown in the last example, there could be an overlap between subsystem software testing and the other types of testing.

5. Finally, acceptance testing is performed. This involves testing the OSCAR model with actual data. Again note that any analytical testing of the OSCAR model also tested the validity the OSCAR database.

To satisfy the customers' needs of this OSCAR software model the order of testing was slightly modified. Alpha testing was completed first followed by beta testing and V&V testing will be completed next.

B. Analysis and Evaluation

Some of the specific items verified during alpha testing were: the use of user input values over the default values; the wording of the input section to prompt the correct user input responses (ie. decimal verses $K/unit); the use of the proper format of the input default entries (FY91$ or decimal or are in thousands); the verification of the detail, output, and schedule sections' equations; the verification of the horizontal and vertical totals; the verification of the proper escalation calculations; the verification of different inputs such as 2 verses 3 levels of maintenance; and the completion of "what ifs?" (ie, what if the user wants constant FY94$?) to signal modification requirements to the documentation to answer these "what if" questions.

Next, data from the Harpoon missile program was entered into the OSCAR model. The output generated was verified for accuracy. Each CER was hand calculated and compared to the results on the output report. Then comparisons between the estimated CBS costs and the actual costs experienced by the Harpoon missile were made. If a cost was off by a significant percentage, the formula and CERs were verified. Corrections were made and the output reports were regenerated. Alpha testing proved to be successful. For example, the intermediate level maintenance costs calculated for the Harpoon missile matched the intermediate level costs anticipated by the Yorktown facility. This Alpha testing process must be completed for any future updates.

Beta testing was performed by one user. The developer accompanied the user during beta testing. While the user entered the data, the programmer took notes. This was done to note problems which the user experienced while using the software. For example, the user may have

experienced menu or documentation interpretation problems. This would alert the developer to expand on documentation in certain areas, change menus, add examples to documentation, etc. Beta testing was completed both to demonstrate the OSCAR model's capabilities to the user and to validate that the OSCAR model is fulfilling all of the customers' needs.

The next step was to analyze the notes taken during the beta testing and to evaluate the output reports generated. The model was changed accordingly. Once these changes were made they were reviewed by the user.

Finally, V&V will take place. Verification testing is similar to the alpha testing as described above. The Validation portion of V&V will be a test to ensure that the model is successfully fulfilling all of customers' needs. After V&V testing, the OSCAR system will be fully implemented. As noted by Figure 4--OSCAR System Life-Cycle Time Line, V&V testing will begin in November of 1991. This is estimated to take approximately one month.

C. Test Documentation

Any notes pertaining to documentation during the case study were reviewed and the documentation was revised accordingly. Once changes were made they were reviewed by the user.

D. Implementation Revisions

Finally, an overall review of the model and documentation is completed. If any problems exists, they are to be fixed by the programmer and then reviewed by the user.

VII. OSCAR System Implementation

A. Introduction Presentations

To fulfill the customers' needs and to quicken the implementation process, limited introductory presentations will occur prior to V&V completion.

Once all the testing is completed the OSCAR system can be fully released to all of the users. NAVAIR 524 and NAVAIR 418 should receive separate briefings since they are both large divisions and have slightly different needs and responsibilities for this OSCAR system. These briefings will involve reviewing the purpose, application, capability, CBS definitions, CBS CERs, and maintenance requirements (distribution, revision bulletins, and update process).

B. Operator Training

Once the users are introduced to the OSCAR system, the users should then be given operator manuals. After discussing and answering questions pertaining to the contents of the users manual, each user should be given a sample missile O&S data system to input into the model. After each analyst can successfully manipulate the software and all general questions have been answered, training is complete. The analysts will be informed as to whom in NAVAIR will be available for future assistance.

C. Distribution

A distribution list is to be located at NAVAIR containing the department codes, points of contact, autovon numbers, phone numbers, quantity of copies, and addresses of all of the divisions which have a copy of OSCAR system.

VIII. OSCAR System Maintenance

A. Update and Enhancement

Any additional modifications after V&V will be handled as a model enhancement. Before implementing any model enhancements, customer surveys will be completed to ensure that all the users agree with the proposed changes. In addition, any OSCAR model reprogramming will require the analysis of software design sensitivities (see Section IV part D) and a repeat of the extensive testing as initially performed and defined in Section VI.

In addition, the model will be reviewed annually by NAVAIR to update the CERs. All CER data updates will be sent to NAVAIR for review and implementation.

The revised pages of the users manual and the revised model will be distributed to all the users. If any major modifications or updates are made to the model prior to the annual review, the revised pages of the users manual and the revised model will be distributed to all the users. The enhancements which may occur within the first year are included in Section X part B.

B. Data Collection

All updated information will be sent to NAVAIR for analysis. This includes manuals, factors, etc. which are to be collected by NAVAIR annually.

IX. Summary of Results

The objectives of this project and report were to 1) to aid analysts in understanding the role that O&S plays in the missile system's life cycle; and 2.) to develop an O&S cost estimating system which provides analysts with a database, model, and methodology for collecting, estimating, and maintaining this O&S cost estimating system.

The first objective was accomplished by describing how the O&S phase relates to the overall life cycle of a missile system. This objective was achieved by first describing a generic missile system and by then describing a generic missile system's life cycle.

The second objective of this project was accomplished by implementing the OSCAR system life-cycle process as defined by Figure 3.

As defined by Figure 3 the six step OSCAR system life-cycle process consists of:

1.) Identify the Need for the Cost Estimating Methodology
2.) Analyze the OSCAR System
3.) Establish the OSCAR System
4.) Test and Debug the OSCAR System
5.) Implement the OSCAR System
6.) Maintain the OSCAR System

The methodology implemented to complete each of the steps of the OSCAR system life-cycle process were discussed in detail within this report.

The results of this project involved the design and development of a "new" state-of-the-art missile system **O&S Cost AnalyzeR** (OSCAR) system which will provide NAVAIR with an effective tool to aid analysts in completing O&S budget estimates and proposal evaluations. The OSCAR system consists of the OSCAR database and OSCAR model. The implementation of the final phases of the OSCAR system will keep both the OSCAR database and OSCAR model maintained and updated. This will provide the user with an O&S cost estimating system which will continually fulfill their needs.

X. Conclusion and Recommendations

A. Overview

The OSCAR system database and model was designed and developed by Rosemarie Bolha with as much flexibility as possible to provide analysts with a tool to better plan and estimate O&S missile system cost. Flexibility characteristics include: multiple levels of maintenance, multiple delivery schedules, multiple LRFP year display, ability to complete modifications as required, ability to expand and update the OSCAR system as appropriate. The software chosen for the OSCAR model was Lotus 1-2-3 due to its flexibility. In addition, since this software is known by most analysts, the OSCAR model will be easily interpreted, updated, and modified to fit specific program needs (this is encouraged, since model maintenance is essential).

As noted earlier, V&V must be completed before fully implementing this model. V&V is to be completed by an independent test agent. This is estimated to take approximately one month. As mentioned, a limited amount of implementation will begin prior to the completion of V&V to fulfill the users' needs.

B. Areas of Further Analyses

1. Complete a detailed repair analysis based on missile system's history. This is required to determine the most accurate method to use to determine missile system repair costs.

This analysis will involve breaking the missile down into it's component and sub-component parts and completing an in-depth analysis. It is proposed that for each component (guidance system) and sub-component (seeker) that the MTBF, Mean Time to Repair (MTTR), repair costs, failure rate, scrap rate be analyzed. The results of this analysis will indicate what components and/or sub-components are true cost drivers to "repair costs". For example, it may be determined that the Guidance and Propulsion Sections should be broken out to sub-components when completing failure analysis and estimating costs. It may also be determined that a component level (rather than sub-component) analysis of the control, wings and fins, container, and warhead section is appropriate.

2. Determine whether or not the OSCAR model should be designed to be sensitive to missile system environment. Environments of concern include: carrier (Navy Aircraft), ship, submarine, captive carry, and training. From this analysis, it will be determined whether or not a separate repair percentage (factor) should be added for each of these types of missile environments. If this is necessary the schedule could be modified (break out the delivery schedule by missile type) and repair factors can be added.

3. Determine whether or not the OSCAR system should be designed to be sensitive to organic verses inorganic depot maintenance facilities. From this analysis, it will be determined whether or not Cost Estimating Relationships should be modified.

4. Further enhance the CERs contained within the OSCAR system. This would involve a detailed investigation of the CERs. Such as analyzing additional missile systems' program history, and; evaluating and

updating the cost parameters used in this model. From this analysis, the OSCAR system can be updated as appropriate. Model maintenance is a continuous effort. To aid in this analysis, discussions with the program office, logistics, intermediate level planners, Pacific Missile Test Center (PMTC) engineers, cost analysts, etc. should occur. In addition, the identification and analysis of other existing models should occur. Of course, the same verification and validation process shown in this report, should be used to test and debug any new information developed into the model.

5. Determine how to modify the OSCAR system to predict aircraft O&S estimates.

6. Examine the effects of major retrofits on a program's O&S budget. (For this project, it was assumed that retrofit was level loaded at some dollars per missile per year.) In-scope retrofits are calculated as a part of the program's O&S budget. Major retrofits are separately funded and planned. In those years where major retrofits occurs, what is the net effect on a weapon system's O&S budget? As part of this analysis it must be determined if past history indicates that major retrofits are common. If it can be shown that major retrofits are common, then it should be determined if any trends exist. For example, it may be shown that major retrofits occur the fourth and eighth year after production of most missile systems. Once trends are found it should be determined how the regular O&S budgets are affected. It may be determined that the net effect is a level loading effect as assumed by this project. Or it may be determined that during the fourth and eighth year after production the material costs should be increased by 50% since retrofits usually involve hardware and software changes.

7. Modify the model to perform additional analyses. Economic analyses requiring the use of an interest rate representing the cost of money can be accomplished by adding an interest formula equation to the model. For example, if the basis of the evaluation of the alternatives is the "present equivalent", the then year dollar yearly total program costs should be multiplied by (1+i)^(-t) (where i = nominal annual interest rate, t = time (0 to n), and n = number of years).

Risk assessments can be completed with the current model by consciously modifying input values to represent high, medium, or low risk figures. A potential follow on effort would be for risk to be in the form of explicit input questions (ie., high, low) to be answered by the user for each cost category.

8. Incorporate missile system disposal costs into the model. The development of CER(s) for missile system disposal costs should take into consideration environmental conditions such as recycling.

9. The final area of investigation is software maintenance. In the past, software has not played such a significant rule in operation and support costs. But the complexity of this area has increased drastically; thus, this element's rule as a major cost driver in a missile system's O&S costs, is an area which needs further analysis. For example, the Tomahawk software maintenance accounts for approximately 30% of the Tomahawk's yearly O&M,N budget[46]. This includes maintenance of the Operational Flight Software, Common Weapon Control System, and Common Control System Software. Tecolote Research, Incorporated analyzed the Tomahawk software maintenance requirements and developed CERs for Operational Flight Software and for the Common Weapon Control System[47]. Thus it is suggested that further analysis be investigated and that relevant CERs be developed into the model.

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Appendix A: CBS Comparisons

Comparison of LRFP CBS to Professor Blanchard's CBS:

LRFP includes program sponsor's costs only. From the matrix diagram and from the information below one will see that the relationship between Professor Blanchard's CBS and the LRFP CBS is not a clear cut "one for one" relationship. Most of the LRFP CBS elements map into a number of Professor Blanchard's CBS elements or vise versa. By presenting the sub-elements of the two CBS one will be able to make this distinction. Remember that it was necessary to use the LRFP CBS as the database format because missile history and program sponsors budgets are tracked using the LRFP format.

Technical Data Comd - includes the LRFP elements of Technical Data and Computer Resources Support. LRFP Technical Data includes technical manual maintenance (ie. changes, updates, printing, and distribution). These costs are identified in the LRFP Technical Data category under the sub-elements of contractor and government maintenance. LRFP Computer Resources Support includes maintenance of all software maintenance documentation. These costs are identified in the LRFP Computer Resources Support category under the sub-element of Software and Hardware Maintenance which are government people.

Maintenance Facilities Comf - includes the LRFP elements of facilities maintenance. Facilities maintenance can be shown in the LRFP format either under the LRFP Maintenance category or under the LRFP Facilities category. If facilities maintenance is included in the overhead rate it will be located in the LRFP Maintenance category under the depot and intermediate level sub-elements of recertification and repair. Otherwise, facilities maintenance will be located under the LRFP Facilities category under the sub-elements of intermediate and depot level facilities maintenance.

Maintenance Personnel Comm - includes the LRFP categories of Maintenance, Support and Test Equipment, Computer Resources, and ILS Program Management. LRFP Maintenance includes both preventive and corrective personnel activity costs. These costs are identified in the LRFP Maintenance category under Intermediate and Depot sub-elements of recertification and repair. LRFP Support and Test Equipment includes the sub-element of Contractor Sustaining Engineering. As part of their responsibilities, these engineers analyze equipment plans and perform failure analysis. LRFP Computer Resources includes maintenance of computer hardware and software. These costs are identified in the LRFP Computer Resources category under the sub-elements of Software and Hardware Maintenance. The LRFP ILS category includes the manager(s) of the Contractor Sustaining Engineers under the sub-element of Contractor.

Replenishment Maintenance Training Comp - includes the LRFP categories of Maintenance, Related Programs, Computer Resource Support, Facilities, and Training & Training Support. The LRFP category of maintenance can include the labor of both the depot and intermediate level personnel for training. Also included in the LRFP element of Maintenance is the sub-element of Production and Support Personnel. Production and Support Personnel includes the intermediate level planners, etc. Also, the LRFP category of Related Programs could include training transportation. The LRFP category of Computer Resources Support includes the costs associated with the training for software and hardware. The LRFP category of Facilities includes the training costs associated with the maintenance of the training

facilities. (These costs could be included in the overhead of the Maintenance sub-elements of repair and recertification). The LRFP Training and Training Support category includes the majority of the costs associated with training. The LRFP Training and Training Support Category includes the elements of training course development, training devices and aids, analysis, studies, plans, data and other.

Test & Support Equipment Maintenance Coms - includes the LRFP categories of Maintenance, Support and Test Equipment, Related Programs, and Computer Resources Support. The LRFP category of Maintenance includes the repair of the Support and Test Equipment. This repair is included in Maintenance under the sub-elements of Intermediate level Non-Quantity Oriented and Depot level Support and Test Equipment. The LRFP category of Support and Test Equipment includes the indirect engineering support of software, hardware, test and support equipment maintenance under the sub-element of Contractor Sustaining Engineering. On-site hands on support of test and support equipment maintenance is included in the LRFP category of Related Programs. These hands on efforts are completed by the sub-elements of Contractor Engineering Technical Services and Navy Engineering Technical Services. Computer Resources maintenance is included in the LRFP category of Computer Resources under the Software and Hardware sub-elements.

Transportation and Handling Comt - includes the LRFP categories of Related Programs in which the element transportation is located.

Spare/Repair Parts Comx - includes the LRFP categories of Supply Support and Maintenance. Supply Support is divided between the depot and intermediate sub-elements. Indirect support is included in the LRFP Categories of Maintenance and Supply Support. The LRFP Maintenance category includes the sub-elements of management SPCC and management ASO. The LRFP element of Supply Support contains the sub-element of Supply, Analysis, Plans, and Data. Supply, Analysis, Plans, Data includes internal supply support which is a cost shared by all program sponsors for developing sparing models and other tools. This sub-element in included under the LRFP category of Supply Support.

/Equipment Mods Con - For non-major modifications or retrofits these costs are included under the LRFP element of Related Programs under the sub-element Retrofit.

Support and Handling Equipment Cooe - is not included in the program sponsor's LRFP.

Operational Facilities Coof - is not included in the program sponsor's LRFP.

Operations for Support & Handling Equipment Cooo - is not included in the program sponsors' LRFP.

Operating Personnel Coop - includes the LRFP category of Support and Test Equipment. The sub-element which supports this effort is Contractor Sustaining Engineering. These engineers perform software changes for the fleet.

Operator Training Coot - includes the LRFP category of Training & Training Support. The sub-element which supports this effort is "other" which includes Program Sponsor's Test Flight costs.

Equipment Corrective (unsched) Maint Coou - is not included in the program sponsors' LRFP.

Equipment Prev (sched) Maintenance Coos - is not included in the program sponsors' LRFP.

Phase-out & Disposal Cop - is not included in the LRFP. The Army munitions division plans and incurs all Navy Weapons s disposal costs.

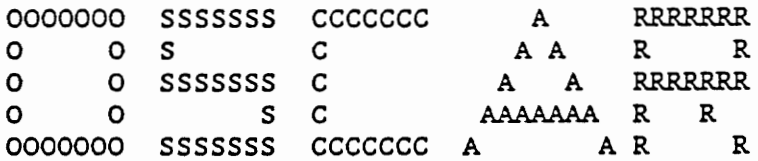
The LRFP includes the sub-elements of Configuration Management, Standardization, and s Effectiveness Engineering which would be included in a number of Professor Blanchard's CBS.

Matrix of Professor Blanchard's CBS vs. the Logistic Report Funding Planning (LRFP) CBS

Elements	Maintenance		Technical Data		Supply Support		Support & Test Equipment		Computer Resource Support		Facilities		Training & Training Support		ILS Program Management		Related Program		System Disposal
Claimant	OPNAV	Fleet	OPNAV	Fleet	OPNAV	Fleet	OPNAV	Fleet	OPNAV	Fleet	OPNAV	Fleet	OPNAV	Fleet	OPNAV	Fleet	OPNAV	Fleet	Army
Technical Data Comd			Y	X					Y	X									
Maintenance Facilities - Comf	Y										Y								
Maintenance Personnel - Comm	Y						Y		Y						Y		Y		
Replenishment Maintenance Training - Comp	Y								Y		Y		Y				Y		
Test & Support Equip Mnt - Coms	Y						Y		Y								Y		
Transportation & Handling - Comt																	Y		
Spare/Repair Parts - Comx	Y				Y	X													
System/Equipment Mods - Con																	Y	X	
Support & Handling Equipment - Cooe								X											
Operational Facilities - Coof												X							
Operations for Suppt & Handl Equipment - Cooo								X											
Operating Personnel - Coop				X			Y												
Equipment Prev (Scheduled) Maintenance - Coos		X								X									
Operator Training - Coot										X			Y	X			Y	X	
Equip Corrective (unsched) Maint - Coou		X								X									
Phase-out & Disposal - Cop																			Z

Note: Y = PROGRAM SPONSOR COSTS; X = FLEET COSTS; Z = ARMY COSTS

Appendix B: Input



OPERATING AND SUPPORT COST ANALYZER

DESIGNED AND DEVELOPED BY:

ROSEMARIE BOLHA 1991

(PRESS ENTER TO CONTINUE)

OPERATION AND SUPPORT COST ANALYZER (OSCAR)
"INPUT" SECTION

(Input all dollars as base year dollars)
(Check for errors in "input" column!!!)

		User Entry	Model Defaults	Input
	----------BACKGROUND INFORMATION----------			
1	FY to Begin Display of the LRFP Output (19xx).	1993	1991	1993
2	Output in TY$ = 1, Constant (FY$) = 0.....	0	0	0
3	Weapon System Name:.....	MAC		
4	AUR Missile Cost ($K/unit).....	1000		1000
5	Missile Shipping Weight.....	1000		1000
6	Missile Length (inches).....	182.5		182.5
7	Missile Diameter (inches).....	13.5		13.5
8	Number of Years of Production (Maximum = 15)..	15		15
	----------MAINTENANCE----------			
9	Levels of Maintenance (2= O/D or 3= O/I/D)....	2	3	2
10	At what level of maintenance is AUR first	N/A	N/A	
	tested during recertification?	N/A	N/A	
	(2= Intermediate level, 3 = Depot level).....	3	2	3
11	If the levels of maintenance are 3 and if	N/A	N/A	
	the AUR is tested at the Depot level, what is	N/A	N/A	
	yearly "I" Maint cost ($K/year).....	10		10
12	Continuation of question above: Does this "I"	N/A	N/A	
	cost include repair of any of the components	N/A	N/A	
	listed in 26-46? So as not to double count	N/A	N/A	
	(repairs done at I vs repair done at D) put	N/A	N/A	
	the cost of those I comp repairs here $K/year.	5		5
13	Number of Depots.....	1	1	1
14	Number of Intermediate Facilities.....	4	4	4
15	Spare Parts Turn Around Time (MONTHS).....	3	3	3
16	System In Servive Time (3,4, or 5 YEARS).....	3	4	3
17	Recertification Hours Per Missile.....	20	18.22	20
18	Intermediate Labor - Avg $ Per Hour (Loaded)..		52.29	52.29
19	Depot Labor - Avg $ Per Hour (Loaded).....	80	69.56	80
		N/A	N/A	
20	Mgmt of Spares- NR SPCC Admin Cost ($K).....	0	0	0
21	Number of SPCC Items.....	0		0
22	SPCC Item Retention Cost ($K/item).....	0		0
23	Mgmt of Spares - NR ASO Admin Cost ($K).....	0	0	0
24	Number of ASO Items.....	0		0
25	ASO Item Retention Cost ($K/item).....	0		0
		N/A	N/A	
26	Guidance & Control Section Cost ($K/unit).....	200		200
27	Guidance & Control Section Weight.....	150		150
28	% Fail - See attachment (decimal).....	0.2	0.1941	0.2
29	Repair Cost ($K/unit).....	50	66	50
30	Percent Scrap (decimal).....	0.1	0.08	0.1
		N/A	N/A	
31	Propulsion Section Cost ($K/unit).....	150		150
32	Propulsion Section Weight.....	200		200

OPERATION AND SUPPORT COST ANALYZER (OSCAR)
"INPUT" SECTION

(Input all dollars as base year dollars)
(Check for errors in "input" column!!!)

	User Entry	Model Defaults	Input
33 % Fail - See attachment (decimal)	0.1	0.0911	0.1
34 Repair Cost ($K/unit)	20	45	20
35 Percent Scrap (decimal)	0.05	0.04	0.05
	N/A	N/A	
36 Warhead Section Cost ($K/unit)	100		100
37 Warhead Section Weight	500		500
38 % Fail - See attachment (decimal)	0.01	0.016	0.01
39 Repair Cost ($K/unit)		30	30
40 Percent Scrap (decimal)		0.004	0.004
	N/A	N/A	
41 Wing and Fin Section Cost ($K/unit)	6		6
42 Wing and Fin Section Weight	100		100
43 % Fail - See attachment (decimal)	0.05	0.1123	0.05
44 Repair Cost ($K/unit)		2.4	2.4
45 Percent Scrap (decimal)		0.005	0.005
	N/A	N/A	
46 Container Section Cost ($K/unit)	600		600
47 Container Section Weight	300		300
48 % Fail - See attachment (decimal)	0.2	0.389	0.2
49 Repair Cost ($K/unit)		42	42
50 Percent Scrap (decimal)		0.005	0.005
	N/A	N/A	
51 Analysis/Studies, Plan, Data ($K/year)	50		50
52 Other ($K/year)	100		100
----------TECHNICAL DATA----------			
Contractor	N/A	N/A	
53 Technical Data: Number of Documents	50		50
54 Average Number of Pages Per Document	1		1
55 Percent Mods Per year (decimal)	0.05		0.05
56 Hours Per Page for Revisions		4	4
57 Tech Data Labor Rate Personnel ($K/hour)	90	76.96	90
Government	N/A	N/A	
58 Technical Data: Number of Documents	500		500
59 Average Number of Pages Per Document	100		100
60 Percent Modification Per year (decimal)	0.05		0.05
61 Hours Per Page for Revisions		4	4
62 Labor Rate of Tech Data Personnel ($K/hour)	30	32.32	30
63 Other ($K/year)	50		50
----------SUPPLY SUPPORT----------			
64 Analysis/Studies, Plan, Data ($K/year)	100		100
65 Other ($K/year)	10		10

OPERATION AND SUPPORT COST ANALYZER (OSCAR)
"INPUT" SECTION

	(Input all dollars as base year dollars) (Check for errors in "input" column!!!)	User Entry	Model Defaults	Input
	-------SUPPORT AND TEST EQUIPMENT (S&T)-------			
66	Is Depot S&T Maint in Overhead (0=YES, 1=NO)?.	1		1
67	If no, Investment $K of Depot S&T & Train Eqt.	1000		1000
68	Additional "I" level investment $K of S&TE	N/A	N/A	
	Train Eqt (excluding AUR test sets) ($K).....	500		500
69	Qty of Contr O&M,N Supt Persl Per Depot.....	1		1
70	Contr Supt Persl Labor Salary ($K/year).....	200	160.616	200
71	Other ($K/year).....	50		50
	---------COMPUTER RESOURCES SUPPORT----------			
72	Software Maint.- LOC/HR.....		1.1494	1.1494
73	Software Personnel $/HR.....	90	76.96	90
74	Number of Lines of Code.....:.....	5000		5000
75	Other ($K/year).....	50		50
	-----------------FACILITIES-----------------			
76	Is Depot Fac Maint in Overhead (0=YES, 1=NO)?.	1		1
77	If no, what is cost of "D" facility ($K/year)?	5000		5000
78	Is "I" Fac Maint in Overhead (0=YES, 1=NO)?...	1		1
79	If no, what is cost of "I" facility ($K/year)?	1000		1000
	--------TRAINING AND TRAINING SUPPORT---------			
80	Qty of Instructors/year.....	10		10
81	Instructors Salary ($K/year).....	70	67.452	70
82	Training Devices and Aids Cost ($K/year).....	15		15
83	Analysis/Studies, Plan, Data ($K/year).....	50	0	50
84	Other ($K/year).....	100		100
	------------ILS PROGRAM MANAGEMENT------------			
85	Qty of ILS Govt Personnel/year.....	1		1
86	Salary Government ILS Personnel ($K/year).....	70	67.452	70
87	Qty of ILS Contractor Personnel/year.....	2		2
88	Salary Contractor ILS Personnel ($K/year).....	200	170.675	200
89	Plans ($K/year).....	50	0	50
90	Other ($K/year).....	100	0	100
	--------------RELATED PROGRAMS--------------			
91	Qty of Configuration Mgmt Personnel/year.....	1		1
92	Annual Salary onf Mgmt Personnel ($K/year)....	70	67.452	70
93	Qty of Standardization Personnel/year.....	2		2
94	Salary of Conf Mgmt Personnel ($K/year).....	70	67.452	70
95	Qty of Contractor Engr Tech Service/year.....	2		2

OPERATION AND SUPPORT COST ANALYZER (OSCAR)
"INPUT" SECTION

(Input all dollars as base year dollars)
(Check for errors in "input" column!!!)

		User Entry	Model Defaults	Input
96	Salary of Contr Eng Tech Serv (CET) ($K/year).	200	160.616	200
97	Will the CET be reqt after Prod (1=YES,0=NO)?.	1		1
98	Qty of Navy Technical Serv Personnel/year.....	4		4
99	Salary of Navy Tech Serv Persl ($K/year).....	70	67.452	70
100	Qty of Systems Effectiveness Engr/year.....	10		10
101	Annual Salary of System Effect Engr ($K/year).	70	67.452	70
102	Average Unit Retrofit Cost ($K/unit).....	10		10
103	Number of Flight Test Per Year.....	2		2
104	Average Cost Per Flight Test ($K).....	500		500
105	Yearly Missile Attrition (Qty/year).....	2		2
106	Contractor $K/lb to ship.....		0.0025	0.0025
107	Government $K/lb to ship.....		0.0016	0.0016
108	Other ($K/year).....	50		50
	--------DEMILITARIZATION AND DISPOSAL---------			
109	Number of Years Until System Disposal.....	20	20	20

Input yearly production quantities and budget escalation numbers below. Use menu or GOTO manual to input your own recertification schedule.

110 If using your recert schedule answer 1=yes... 0

111 GOTO "OUTPUT" then GOTO "OUTWPN" to input FUNDED dollars in "THOUSANDS" (and ESCALATED IF REQUIRED)!!!!

		Entry	Default	Input
112	First Delivery Year (19xx).....	1991	1991	1991

(Note: The first delivery year must match the first year of escalation (as entered below) defaults are 1991.
Input Production DELIVERY Quantities & Escalation O&M,N and WPN.
Hit right arrow key to move to O&M,N and WPN escalation.

Year	User Entry Del Qty	User Entry O&M,N Esc	Model Default	Input	User Entry WPN Esc	Model Default	Input
	0						
1	100	0.0000	1.0000	1.0000	0.0000	1.0000	1.0000
2	150	0.0000	1.0225	1.0225	0.0000	1.3660	1.3660
3	150	0.0000	1.0638	1.0638	0.0000	1.0733	1.0733
4	200	0.0000	1.1044	1.1044	0.0000	1.1104	1.1104
5	300	0.0000	1.1452	1.1452	0.0000	1.1482	1.1482
6	300	0.0000	1.1868	1.1868	0.0000	1.1873	1.1873
7	300	0.0000	1.2298	1.2298	0.0000	1.2277	1.2277
8	500	0.0000	1.2744	1.2744	0.0000	1.2694	1.2694
9	400	0.0000	1.3207	1.3207	0.0000	1.3126	1.3126
10	300	0.0000	1.3686	1.3686	0.0000	1.3572	1.3572
11	500	0.0000	1.4183	1.4183	0.0000	1.4033	1.4033
12	500	0.0000	1.4698	1.4698	0.0000	1.4510	1.4510
13	400	0.0000	1.5231	1.5231	0.0000	1.5004	1.5004
14	300	0.0000	1.5785	1.5785	0.0000	1.5514	1.5514
15	300	0.0000	1.6358	1.6358	0.0000	1.6041	1.6041
16	stop	0.0000	1.6952	1.6952	0.0000	1.6587	1.6587
17		0.0000	1.7569	1.7569	0.0000	1.7151	1.7151
18		0.0000	1.8207	1.8207	0.0000	1.7734	1.7734
19		0.0000	1.8869	1.8869	0.0000	1.8337	1.8337
20		0.0000	1.9556	1.9556	0.0000	1.8960	1.8960
21		0.0000	2.0267	2.0267	0.0000	1.9605	1.9605
22		0.0000	2.1005	2.1005	0.0000	2.0271	2.0271
23		0.0000	2.1769	2.1769	0.0000	2.0961	2.0961
24		0.0000	2.2562	2.2562	0.0000	2.1673	2.1673
25		0.0000	2.3464	2.3464	0.0000	2.2540	2.2540
26		0.0000	2.4403	2.4403	0.0000	2.3442	2.3442
27		0.0000	2.5379	2.5379	0.0000	2.4379	2.4379
28		0.0000	2.6394	2.6394	0.0000	2.5354	2.5354
29		0.0000	2.7450	2.7450	0.0000	2.6369	2.6369
30		0.0000	2.8548	2.8548	0.0000	2.7423	2.7423
31		0.0000	2.9690	2.9690	0.0000	2.8520	2.8520
32		0.0000	3.0878	3.0878	0.0000	2.9661	2.9661
33		0.0000	3.2113	3.2113	0.0000	3.0847	3.0847
34		0.0000	3.3397	3.3397	0.0000	3.2081	3.2081
35		0.0000	3.4733	3.4733	0.0000	3.3365	3.3365
36		0.0000	3.6122	3.6122	0.0000	3.4699	3.4699
37		0.0000	3.7567	3.7567	0.0000	3.6087	3.6087
38		0.0000	3.9070	3.9070	0.0000	3.7531	3.7531

Appendix C: LRFP Output

OUTPUT FILE: O&M,N

POINT OF CONTACT
Name:
Code:
Phone:

WEAPON SYSTEM: MAC

WEAPON SYSTEM SUPPORT SUMMARY FUNDING PROFILE

Dollars: FY$
(O&M,N) Thousands

SUPPORT ELEMENT		1993	1994	1995	1996	1997	1998	1999
1. Maintenance	Required	0.000	3179.170	4621.457	4987.585	8716.712	12646.723	13135.712
	Funded							
2. Technical Data	Required	0.000	350.900	350.900	350.900	350.900	350.900	350.900
	Funded							
3. Supply Support	Required	0.000	110.000	110.000	110.000	110.000	110.000	110.000
	Funded							
4. Support & Test Equipment	Required	200.000	250.000	250.000	250.000	250.000	250.000	250.000
	Funded							
5. Computer Resources Support	Required	0.000	50.000	50.000	50.000	50.000	50.000	50.000
	Funded							
6. Facilities	Required	0.000	362.400	362.400	362.400	362.400	362.400	362.400
	Funded							
7. Training & Training Support	Required	0.000	1865.000	1865.000	1865.000	1865.000	1865.000	1865.000
	Funded							
8. ILS Program Management	Required	0.000	620.000	620.000	620.000	620.000	620.000	620.000
	Funded							
9. Related Programs	Required	280.000	1681.826	1895.725	1950.023	2503.072	3085.912	3158.432
	Funded							
Totals	Required	480.000	8469.296	10125.482	10545.908	14828.084	19340.935	19902.444
	Funded	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Deltas	-480.000	-8469.296	-10125.482	-10545.908	-14828.084	-19340.935	-19902.444

OUTPUT FILE: WPN

POINT OF CONTACT
Name:
Code:
Phone:

WEAPON SYSTEM: MAC

WEAPON SYSTEM SUPPORT SUMMARY FUNDING PROFILE
Dollars: FY$
(WPN) Thousands

SUPPORT ELEMENT		1993	1994	1995	1996	1997	1998	1999
1. Maintenance	Required							
	Funded							
2. Technical Data	Required							
	Funded							
3. Supply Support	Required	0.000	4109.978	6099.718	6604.817	11749.416	17171.148	17845.744
	Funded							
4. Support & Test Equipment	Required							
	Funded							
5. Computer Resources Support	Required							
	Funded							
6. Facilities	Required							
	Funded							
7. Training & Training Support	Required							
	Funded							
8. ILS Program Management	Required							
	Funded							
9. Related Programs	Required	400.000	1728.800	2372.104	2535.408	4198.712	5951.616	6169.720
	Funded							
Totals	Required	400.000	5838.778	8471.822	9140.225	15948.128	23122.764	24015.464
	Funded	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Deltas	-400.000	-5838.778	-8471.822	-9140.225	-15948.128	-23122.764	-24015.464

Appendix D: Schedule

			Sist (Yr)	3											
year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Delivery	100	150	150	200	300	300	300	500	400	300	500	500	400	300	300
Cum Inven	100	250	400	600	898	1196	1494	1992	2390	2688	3186	3684	4082	4380	4678
Recertification				100	148	148	298	446	446	596	944	844	894	1442	1342
Attrition				2	2	2	2	2	2	2	2	2	2	2	2
round #				1			2			3			4		

WHERE: ROUND # IS THE NUMBER OF RECERTIFICATION CYCLES (@ ONCE EVERY FOUR YEARS (OR SIST TIME))

year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Delivery stop							----------Phase out----------					PHASE OUT	----------		
Cum Inven	4676	4674	4672	4670	4668	4666	4664	4662	4660	4658	4656	4654	4652	4650	4648
Recertifi	1292	1740	1640	1290	1738	1638	1188	1586	1486	986	1284	1184	684	782	782
Attrition	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
round #	5			6			7			8			9		

year	2021	2022	2023	2024	2025	2026	2027	2028	TOTAL
Delivery									4700
Cum Inven	4646	4644	4642	0	0	0	0	0	115880
Recertifi	382	280	280	0	0	0	0	0	27890
Attrition	2	2	2	2	2	2	2	2	70
round #	10			11					

Appendix E: Detail Output

DETAIL SPREADSHEET FY$

Sist (Yr) 3 Sist (Yr) 3

		year	1991	1992	1993	1994	1995
		Delivery	100	150	150	200	300
		Cum Inven	100	250	400	600	898
		Recertification				100	148
91x	MAINTENANCE		0	0	0	3179	4621
	Intermediate Level Maintenance						
915	Intermediate Repair						
915.1	Recertification		0	0	0	0	0
915.2	Repair						
915.21	Repair Labor		0	0	0	0	0
915.22	Mgmt SPCC		0	0	0	0	0
915.23	Mgmt ASO		0	0	0	0	0
915.3	NCO -PC, AUR Test Set Main		0	0	0	0	0
915.4	Other (Samples, QC)		0	0	0	0	0
915.5	Other Supt & Test Eq maint		0	0	0	0	0
	Depot Level Maintenance						
914	Depot Repair						
914.1	Recertification		0	0	0	213	316
914.2	Repair		0	0	0	2767	4106
914.3	Supt and Test Equip maint		0	0	0	50	50
917	Analy/Studies, Plans, Data		0	0	0	50	50
918	Other		0	0	0	100	100
92x	TECHNICAL DATA		0	0	0	351	351
926.1	Contractor Maintenance		0	0	0	1	1
926.2	Government Maintenance		0	0	0	300	300
927	Other		0	0	0	50	50
93x	SUPPLY SUPPORT		0	0	0	4220	6210
932	Interim S&RP						
932.1	Intermediate Replen (WPN)		0	0	0	0	0
932.2	Depot Replenishment (WPN)		0	0	0	4110	6100
933	Supply, Analy, Plans, Data		0	0	0	100	100
934	Other		0	0	0	10	10
94x	SUPPORT AND TEST EQUIPMENT		200	200	200	250	250
948	Contractor Sust Engr		200	200	200	200	200
	(see Maintenance for Equip)						
947	Other		0	0	0	50	50
95x	COMPUTER RESOURCES SUPPORT		0	0	0	50	50
951	Software Maintenance		0	0	0	0	0
952	Hardware Maintenance						
953	Other		0	0	0	50	50

96x	FACILITIES	0	0	0	362	362
967	Other (Usually in OH)					
967.1	Intermediate Fac Maint.	0	0	0	60	60
967.2	Depot Level Fac Maint.	0	0	0	302	302
97x	TRAINING AND TRAINING SUPPORT	0	0	0	1865	1865
971	Training Course Development	0	0	0	700	700
974	Training Devices/Aids	0	0	0	15	15
975	Analy, Studies, Plans, Data	0	0	0	50	50
977	Other (Flight Test)					
977.1	Flight Test	0	0	0	1000	1000
977.2	Other	0	0	0	100	100
98x	ILS PROGRAM MANAGEMENT	0	0	0	620	620
981	Management (WPN, then O&M,N when prod over) PMTC, China Lake, NWS....					
981.1	Government	0	0	0	70	70
981.2	Contractor	0	0	0	400	400
983	Plans	0	0	0	50	50
984	Other	0	0	0	100	100
99x	RELATED PROGRAMS	680	680	680	3411	4268
991	Configuration Management	0	0	0	70	70
992	Standardization	0	0	0	140	140
993	Contr Eng Tech Serv (WPN)	400	400	400	400	400
994	Navy Eng Technical Services	280	280	280	280	280
995	Systems Effectiveness Eng	0	0	0	700	700
997						
9911	Other					
9911.1	Retrofit (WPN)	0	0	0	1329	1972
9911.2	Transportation					
9111.21	Intermediate Level	0	0	0	425	631
9111.22	Depot Level	0	0	0	17	25
9111.3	Other	0	0	0	50	50
	TOTAL	880	880	880	14308.07	18597.30
O&M,N Escalation (If TY$=YES, IF FY$=NO)?	FY$	1	1	1	1	1
WPN Escalation (If TY$=YES, IF FY$=NO)?	FY$	1	1	1	1	1
	O&M,N TY$	1	1.0225	1.0638	1.1044	1.1452
	FY$	1	1	1	1	1
	WPN TY$	1	1.366	1.0733	1.1104	1.1482

Appendix F: Factors

TABLE OF FACTORS		Factor
91x	MAINTENANCE	
	Percent Unsched Maint Of Cum Inv	0.0548
	NQO as a percent of $I repair/recert	0.552
	I" Other - 915	0.117
92x	TECHNICAL DATA	
93x	SUPPLY SUPPORT	
94x	SUPPORT AND TEST EQUIPMENT	
	Support and Test Equipment Maintenance	0.05
95x	COMPUTER RESOURCES SUPPORT	
	Software factor	0.117
96x	FACILITIES	
	Facilities Maintenance	0.0604
97x	TRAINING AND TRAINING SUPPORT	
98x	ILS PROGRAM MANAGEMENT	
99x	RELATED PROGRAMS	

Appendix G: Repair, Replenishment, Transportation

	Repair Analysis			Material Analysis		
	Repair %	Labor K$/comp	K$/labor Rep/rec msl	Scrap %	Material K$/comp	K$/Matl Rep/rec msl
Guidance/Control Section	0.2	50	10	0.1	200	20
Propulsion	0.1	20	2	0.05	150	7.5
Warhead	0.01	30	0.3	0.004	100	0.4
Subtotal			12.3			27.9
Wings and Fins	0.05	2.4	0.12	0.005	6	0.03
Container	0.2	42	8.4	0.005	600	3
Subtotal			8.52			3.03
Total			20.82			30.93

Note: The information taken from the input section is used above in the repair and material (replenishement) calculations. The Labor $K/missile and Material $K/missile are multiplied by the recertification quantities for each year. The costs are allocated to the associated facilities (depot/or intermediate).

Transportation

	Repair %	Weight	lbs/msl to rec msl	Scrap %	Weight	lbs/msl to rec msl
Guidance Section	0.2	150	30	0.1	150	15
Propulsion	0.1	200	20	0.05	200	10
Warhead	0.01	500	5	0.004	500	2
Subtotal			55			27
Wings and Fins	0.05	100	5	0.005	100	0.5
Container	0.2	300	60	0.005	300	1.5
Subtotal			65			2
Total			120			29
Propulsion/Warhead			25			12

Note: Like the Labor and Material costs, the transportations costs are calculated above based on the input. The lbs/missile calculated above are multiplied by the $/lb identified in the input and by the recertification quantities. The costs are allocated to the associated facilities (depot and/or intermediate).

Appendix H: Methodology

Date - Sept 91

WBS: MAINTENANCE 91x

DESCRIPTION: INTERMEDIATE RECERTIFICATION 915.1

CER: 18.22 HRS/RECERT * $52.29/HR * (QTY OF RECERTIFICATIONS + 5.48% UNSCHEDULED MAINT QTY * CUMM INVENTORY QTY)/1000

SOURCES/COMMENTS:

18.22 HRS/RECERT - BASED ON 12 DATA POINTS OF VARIOUS AIR LAUNCHED MISSILES INCLUDING: HARPOON, SPARROW, WALLEYE, PHOENIX, HARM, MAVERICK - FROM "AIRBORNE WEAPONS WORKLOAD SCHEDULE" . THE DEFAULT IS THE MEAN PLUS 3 STANDARD DIVIATIONS. (SEE ATTACHED CHART FOR FACTORS FOR OTHER THAN AIR LAUNCHED MISSILES).

$52.29/HR - BASED ON NAVAL WEAPON STATIONS, YORKTOWN, CONCORD, AND SEAL BEACH - FROM "AIRBORNE WEAPONS WORKLOAD SCHEDULE". FY91$.

5.48% - TOMAHAWK HISTORY

RECERT INCLUDES: 100% INSPECT + REPLACEMENT OF WRA

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) MISSILE DELIVERY SCHEDULE
2.) RECERT HOURS - DEFAULT = 18.22 HOURS
3.) WRAP RATE - DEFAULT = $52.29/HR

Date - Sept 91

WBS: MAINTENANCE 91x

DESCRIPTION: INTERMEDIATE RECERTIFICATION 915.1: (IF ONLY 100% INSPECTION HOURS ARE KNOWN)

CER: (1.393233 * (100% INSPECTION HOURS) + .709266 HOURS) * $52.29/HR * (QTY OF RECERTIFICATIONS + 5.48% UNSCHEDULED MAINT QTY * CUMM INVENTORY QTY)

SOURCES/COMMENTS:

BASED ON OVER 12 DATA POINTS OF VARIOUS MISSILES INCLUDING: HARPOON, SPARROW, WALLEYE, PHOENIX, HARM, MAVERICK - FROM "AIRBORNE WEAPONS WORKLOAD SCHEDULE" .

$52.29/HR - BASED ON NAVAL WEAPON STATIONS, YORKTOWN, CONCORD, AND SEAL BEACH - FROM "AIRBORNE WEAPONS WORKLOAD SCHEDULE". FY91$.

5.48% - TOMAHAWK HISTORY

RECERT INCLUDES: 100% INSPECT + REPLACEMENT OF WRA

IF ONLY THE HOURS FOR THE 100% INSPECTION ARE KNOWN, THE ADDITIONAL TIME REQUIRED TO REPLACE THE WORK REPLACEABLE UNITS (WRA) CAN BE CALCULATED WITH THIS CER.

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) MISSILE DELIVERY SCHEDULE
2.) HOURS FOR 100% INSPECTION
3.) WRAP RATE - DEFAULT = $52.29/HR

Date - Sept 91

WBS: MAINTENANCE 91x

DESCRIPTION: INTERMEDIATE LEVEL REPAIR 915.21

CER: IF LEVELS OF MAINTENANCE EQUALS 3 AND IF AUR IS TESTED AT THE "I" LEVEL:

E(LABOR $K/MISSILE COMP.1 REPAIR * PERCENT FAILURE RATE PER MISSILE COMP.1) * (QTY OF RECERTIFICATIONS + 5.48% UNSCHEDULED MAINT QTY * CUMM INVENTORY QTY).

WHERE: COMP.1 = WINGS & FINS AND CONTAINER

SOURCES/COMMENTS:

LABOR $K/MISSILE COMPONENT REPAIR AND PERCENT FAILURE RATE PER MISSILE COMPONENT ARE DETERMINED BY THE INPUTS TAKEN FROM THE ATTACHED TABLE. DATA FROM NAVAIR 418 . CORRESPONDING DEFAULTS ARE BASED ON THE DATA FROM THE ATTACHED TABLE. THE DEFAULT VALUES ARE THE MEAN PLUS 3 STANDARD DIVIATIONS. FY91$.

5.48% - TOMAHAWK HISTORY

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) MISSILE DELIVERY SCHEDULE
2.) LABOR $K/MISSILE COMPONENT REPAIR OR DEFAULT
3.) PERCENT FAILURE RATE PER MISSILE COMPONENT OR DEFAULT

Date - Sept 91

WBS: MAINTENANCE 91x

DESCRIPTION: MANAGEMENT SPCC OR ASO 915.22

CER: FOR FIRST YEAR: ADMINISTRATION COST + (# ITEMS STOCKED BY SPCC OR ASO) * ITEM RETENTION COST

FOR EACH OF THE FOLLOWING YEARS: (# ITEMS STOCKED BY SPCC OR ASO) * ITEM RETENTION COST

SOURCES/COMMENTS:

UPDATES CAN BE OBTAINED BY SPCC OR ASO: SPCC - JIM BUFFINGTON OR JIM MASTERSON.

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) FIRST YEAR ADMIN COST $K
2.) ITEM RETENTION COST $K/YEAR
3.) NUMBER OF ITEMS STOCKED BY SPCC OR ASO

Date - Sept 91

WBS: MAINTENANCE 91x

DESCRIPTION: INTERMEDIATE LEVEL NON-QUANTITY ORIENTED PERSONNEL (NQO) 915.3

CER: 55.2% * ($REPAIR + $RECERT)

SOURCES/COMMENTS:

BASED ON SIX DATA POINTS (TWO YEARS OF NAVAL WEAPON STATIONS WORKLOAD SCHEDULE FOR YORKTOWN, CONCORD, SEAL BEACH) - FROM THE "AIRBORNE WEAPONS WORKLOAD SCHEDULE FISCAL YEARS 1991-2". THE DEFAULT VALUE IS THE MEAN PLUS 3 STANDARD DIVIATIONS. FY91$.

THIS CATEGORY INCLUDES: TEST SET MAINT, PLANNING, MATL HANDL, TOOLRM MGR, EQUIP SPEC, SUPPLY SUPT, ANCILLARY EQUIP, HOST/TENNANT AT INTERMEDIATE LEVEL MAINT FAC.

ANALYST: ROSEMARIE BOLHA

USER INPUTS: NONE

Date - Sept 91

WBS: MAINTENANCE 91x

DESCRIPTION: INTERMEDIATE LEVEL "OTHER" 915.4

CER: 11.7% * ($REPAIR + $RECERT)

SOURCES/COMMENTS: BASED ON SIX DATA POINTS (TWO YEARS OF NAVAL WEAPON STATIONS WORKLOAD SCHEDULE FOR YORKTOWN, CONCORD, SEAL BEACH) - FROM THE "AIRBORNE WEAPONS WORKLOAD SCHEDULE FISCAL YEARS 1991-2".

THIS CATEGORY INCLUDES: QUALITY CONTROL AND SAMPLES

ANALYST: ROSEMARIE BOLHA

USER INPUTS: NONE

Date - Sept 91

WBS: MAINTENANCE 91x

DESCRIPTION: INTERMEDIATE LEVEL MAINTENANCE SUPPORT & TEST EQUIPMENT AND TRAINING EQUIPMENT (OTHER THAN TEST SET MAINTENANCE & MATERIAL) 915.5

CER: 5% * (SUPPORT & TEST EQUIPMENT INVESTMENT COST)

SOURCES/COMMENTS:

5% - ANALYST JUDGEMENT

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

INVESTMENT $K OF I LEVEL SUPPORT, TEST, AND TRAINING EQUIPMENT (OTHER THAN TEST SETS)

Date - Sept 91

WBS: MAINTENANCE 91x

DESCRIPTION: DEPOT RECERTIFICATION 914.1

CER: 18.22 HRS/RECERT * $69.56/HR * (QTY OF RECERTIFICATIONS + 5.48% UNSCHEDULED MAINT QTY * CUMM INVENTORY QTY)/1000

SOURCES/COMMENTS:

18.22 HRS/RECERT - BASED ON 12 DATA POINTS OF VARIOUS AIR LAUNCHED MISSILES INCLUDING: HARPOON, SPARROW, WALLEYE, PHOENIX, HARM, MAVERICK - FROM "AIRBORNE WEAPONS WORKLOAD SCHEDULE". THE DEFAULT IS THE MEAN PLUS 3 STANDARD DIVIATIONS. (SEE ATTACHED CHART FOR FACTORS FOR OTHER THAN AIR LAUNCHED MISSILES).

$69.56/HR - BASED ON THE ACTUAL PRODUCTION LABOR RATE EXPERIENCED IN FY90. FY91$.

5.48% - TOMAHAWK HISTORY

RECERT INCLUDES: 100% INSPECT + REPLACEMENT OF LRU

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) MISSILE DELIVERY SCHEDULE
2.) RECERT HOURS - DEFAULT = 18.22 HOURS
3.) WRAP RATE - DEFAULT = $69.56/HR

Date - Sept 91

WBS: MAINTENANCE 91x

DESCRIPTION: DEPOT REPAIR 914.2

CER: IF LEVELS OF MAINTENANCE EQUALS 3:
E(LABOR $K/MISSILE COMP.2 REPAIR * PERCENT FAILURE RATE PER MISSILE COMP.2) * (QTY OF RECERTIFICATIONS + 5.48% UNSCHEDULED MAINT QTY * CUMM INVENTORY QTY) - "I" LEVEL INPUT

IF LEVELS OF MAINTENANCE EQUALS 2:
E(LABOR $K/MISSILE COMP.3 REPAIR * PERCENT FAILURE RATE PER MISSILE COMP.3) * (QTY OF RECERTIFICATIONS + 5.48% UNSCHEDULED MAINT QTY * CUMM INVENTORY QTY)

WHERE: COMP.2 = G&C, PROP, WARHEAD
COMP.3 = G&C, PROP, WARHEAD, W&F, CONTR

SOURCES/COMMENTS:

LABOR $K/MISSILE COMPONENT REPAIR AND PERCENT FAILURE RATE PER MISSILE COMPONENT ARE DETERMINED BY THE INPUTS TAKEN FROM THE ATTACHED TABLE. DATA FROM NAVAIR 418 . CORRESPONDING DEFAULTS ARE BASED ON THE DATA FROM THE ATTACHED TABLE. THE DEFAULT VALUES ARE THE MEAN PLUS 3 STANDARD DIVIATIONS. FY91$.

5.48% - TOMAHAWK HISTORY

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) MISSILE DELIVERY SCHEDULE
2.) LABOR $K/MISSILE COMPONENT REPAIR OR DEFAULT
3.) PERCENT FAILURE RATE PER MISSILE COMPONENT OR DEFAULT

Date - Sept 91

WBS: MAINTENANCE 91x

DESCRIPTION: DEPOT SUPT, TEST, & TRAIN EQUIP MAINT 914.3

CER: 5% * INVESTMENT COST OF DEPOT SUPPORT & TEST EQUIPMENT AND TRAINING EQUIPMENT (INCLUDING TRAINING EQUIPMENT)

SOURCES/COMMENTS:

5% - ANALYST JUDGEMENT

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

INVESTMENT $K OF I LEVEL SUPPORT, TEST, AND TRAINING EQUIPMENT (OTHER THAN TEST SETS)

Date - Sept 91

WBS: TECHNICAL DATA 92x

DESCRIPTION: CONTRACTOR MAINTENANCE 926.1

CER: # OF DOC TO BE MAINT BY CONTR * AVG # PAGES/DOC
* PERCENT MOD/YR * 4 HRS/PAGE * 76.96 $/HR/1000

SOURCES/COMMENTS:

4 HRS/PAGE BASED ON WRITING/PRODUCTION REVISION HRS/PAGE 1/9/85.

76.96 $/HR BASED ON THE ACTUAL ENGINEERING LABOR RATE EXPERIENCED IN FY90. FY91$.

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) WRAP RATE - DEFAULT = $76.96/HR
2.) # OF DOC TO BE MAINT BY CONTR
3.) AVG # PAGES/DOC
4.) PERCENT MOD/YR
5.) HOURS/PAGE DEFAULT = 4 HRS/PAGE

Date - Sept 91

WBS: TECHNICAL DATA 92x

DESCRIPTION: GOVERNMENT MAINTENANCE 926.2

CER: # OF DOC TO BE MAINT BY GOVT * AVG # PAGES/DOC
* PERCENT MOD/YR * 4 HRS/PAGE * 32.32 $/HR/1000

SOURCES/COMMENTS:

4 HRS/PAGE BASED ON WRITING/PRODUCTION REVISION HRS/PAGE 1/9/85.

$32.32/HR - FROM ANNA BUKONT - ANALYZED A MIXTURE OF TEN PEOPLE (GM-13, GM-14, G-15. FY91$. (GOVT OH NEVER INCLUDES PERSONNEL AND OTHER COST).

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) WRAP RATE - DEFAULT = $32.32/HR
2.) # OF DOC TO BE MAINT BY CONTR
3.) AVG # PAGES/DOC
4.) PERCENT MOD/YR
5.) HOURS/PAGE DEFAULT = 4 HRS/PAGE

Date - Sept 91

WBS: SUPPLY SUPPORT 93x

DESCRIPTION: INTERMEDIATE REPLENISHMENT 932.1

CER: IF LEVELS OF MAINTENANCE EQUALS 3:
E(COMP.1 MATL $K PER MSL * COMP.1 PERCENT SCRAP RATE PER MSL) * (QTY OF RECERTIFICATIONS + 5.48% UNSCHEDULED MAINT QTY * CUMM INVENTORY QTY)

WHERE COMP.1 = WINGS & FINS, CONTR SECTIONS

SOURCES/COMMENTS:

COMP.1 MATL $K PER MSL AND COMP.1 PERCENT (REPLENISHMENT) SCRAP RATE PER MSL ARE DETERMINED BY THE INPUTS TAKEN FROM THE ATTACHED TABLE. DATA FROM NAVAIR 418 . SCRAP RATE DEFAULTS ARE BASED ON THE TABLES MEAN VALUES PLUS 3 STANDARD DIVIATIONS. FY91$.

5.48% - TOMAHAWK HISTORY

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) MISSILE DELIVERY SCHEDULE
2.) COMPONENT SCRAP RATES - DEFAULTS VARY BY COMPONENT
3.) COMPONENT MATERIAL $K PER MISSILE

Date - Sept 91

WBS: SUPPLY SUPPORT 93x

DESCRIPTION: DEPOT REPLENISHMENT 932.2

CER: IF LEVELS OF MAINTENANCE EQUALS 3:
E(COMP.2 MATL $K PER MSL * COMP.2 PERCENT SCRAP RATE PER MSL) * (QTY OF RECERTIFICATIONS + 5.48% UNSCHEDULED MAINT QTY * CUMM INVENTORY QTY)

IF LEVELS OF MAINTENANCE EQUALS 2:
E(COMP.3 MATL $K PER MSL * COMP.3 PERCENT SCRAP RATE PER MSL) * (QTY OF RECERTIFICATIONS + 5.48% UNSCHEDULED MAINT QTY * CUMM INVENTORY QTY)

WHERE COMP.2 = G&C, PROP, WARHEAD SECTIONS
WHERE COMP.3 = G&C, PROP, WH, W&F, CONTR SECTIONS

SOURCES/COMMENTS:

COMP.x MATL $K PER MSL AND COMP.x PERCENT (REPLENISHMENT) SCRAP RATES PER MSL ARE DETERMINED BY THE INPUTS TAKEN FROM THE ATTACHED TABLE. DATA FROM NAVAIR 418 . SCRAP RATE DEFAULTS ARE BASED ON THE TABLES MEAN VALUES PLUS 3 STANDARD DIVIATIONS. FY91$.

5.48% - TOMAHAWK HISTORY

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) MISSILE DELIVERY SCHEDULE
2.) COMPONENT SCRAP RATES - DEFAULTS VARY BY COMPONENT
3.) COMPONENT MATERIAL $K PER MISSILE

Date - Sept 91

WBS: COMPUTER RESOURCES SUPPORT 95x

DESCRIPTION: SOFTWARE/HARDWARE MAINTENANCE 951 & 952

CER: LOC * 11.7% CHANGES * 76.96 $/HR / 1.1494 LOC/HR

SOURCES/COMMENTS:

1.1494 LOC/HR AND 11.7% CHANGES BASED ON DATA FROM VARIOUS PLATFORMS INCLUDING: F-14A/D, P3, S-3, A-7E.

76.96 $/HR BASED ON THE ACTUAL ENGINEERING LABOR RATE EXPERIENCED IN FY90. FY91$.

ANALYST: JANET LEBOEUF & ROSEMARIE BOLHA

USER INPUTS:

1.) LOC (LINES OF CODE)
2.) PERCENT CHANGES - DEFAULT = 11.7% CHANGES
3.) WRAP RATE - DEFAULT = 76.96 $/HR
4.) LOC/HR - DEFAULT = 1.1494 LOC/HR

Date - Sept 91

WBS: SUPPORT & TEST EQUIPMENT 94x

DESCRIPTION: CONTRACTOR SUSTAINING ENGINEERING 948

CER: QTY OF CONTR SUST ENGR/DEPOT * # DEPOTS * $160.616K/YR

SOURCES/COMMENTS:

$160.616K/YR - BASED ON THE ACTUAL ENGINEERING LABOR RATE EXPERIENCED BY IN FY90. ($76.96/HR * 2087 HRS/YR)/1000. FY91$

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) QTY OF CONTR SUST ENGR/DEPOT
2.) # DEPOTS
3.) CONTRACTOR ANNUAL SALARY ($K) - DEFAULT = $160.616K/YR

Date - Sept 91

WBS: FACILITIES 96x

DESCRIPTION: INTERMEDIATE FACILITY MAINTENANCE 967.1

CER: 6.04% * INTERMEDIATE FACILITY INVESTMENT COST

NOTE: THIS IS USUALLY IN "I" LEVEL OVERHEAD!!!

SOURCES/COMMENTS:

6.04% ANALYST JUDGEMENT (USED BY MDAC)

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

INTERMEDIATE FACILITY INVESTMENT COST (K$)

Date - Sept 91

WBS: FACILITIES 96x

DESCRIPTION: DEPOT FACILITY MAINTENANCE 967.2

CER: 6.04% * DEPOT FACILITY INVESTMENT COST

NOTE: THIS IS USUALLY IN DEPOT LEVEL OVERHEAD!!!

SOURCES/COMMENTS:

6.04% ANALYST JUDGEMENT (USED BY MDAC)

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

DEPOT FACILITY INVESTMENT COST (K$)

Date - Sept 91

WBS: TRAINING & TRAINING SUPPORT 97x

DESCRIPTION: TRAINING COURSE INSTRUCTORS 971

CER: # OF INSTRUCTORS/YR * $67.452/YR

SOURCES/COMMENTS:

$67.452K/YR BASED ON $32.32/HR * 2087 HRS/YR - DATA FROM ANNA BUKONT - ANALZED A MIXTURE OF TEN PEOPLE (GM-13, GM-14, G-15. FY91$. (GOVT OH NEVER INCLUDES PERSONNEL AND OTHER COST).

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) NUMBER OF GOVERNMENT INSTRUCTORS
2.) ANNUAL SALARY - DEFAULT = $67.452/YR

Date - Sept 91

WBS: TRAINING AND TRAINING SUPPORT 97x

DESCRIPTION: FLIGHT TEST 977.1

CER: # FLIGHT TESTS/YEAR * $K/FLIGHT TEST

SOURCES/COMMENTS:

TOMAHAWK AND HARPOON (SLAM) PROGRAM OFFICES. SEE ATTACHED SHEETS FOR DETAILS ON FLIGHT TEST COSTS.

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) NUMBER OF FLIGHT TESTS PER YEAR
2.) $K PER FLIGHT TEST OR THOSE ASSOCIATED WITH HARPOON, SLAM OR TOMAHAWK.

Date - Sept 91

WBS: ILS PROGRAM MANAGEMENT 98x

DESCRIPTION: GOVERNMENT ILS 981.1

CER: # OF GOVT PERSONNEL * $67.452K /YR

SOURCES/COMMENTS:

$67.452K/YR BASED ON $32.32/HR * 2087 HRS/YR - DATA FROM ANNA BUKONT - ANALZED A MIXTURE OF TEN PEOPLE (GM-13, GM-14, G-15. FY91$. (GOVT OH NEVER INCLUDES PERSONNEL AND OTHER COST).

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) NUMBER OF # OF GOVT ILS PERSONNEL
2.) ANNUAL SALARY - DEFAULT = $67.452/YR

Date - Sept 91

WBS: ILS PROGRAM MANAGEMENT 98x

DESCRIPTION: CONTRACTOR ILS 981.2

CER: # OF CONTRACTOR PERSONNEL * $170.675K /YR

SOURCES/COMMENTS:

$170.675K/YR - BASED ON THE ACTUAL MANAGEMENT LABOR RATE EXPERIENCED BY IN FY90. ($81.78/HR * 2087 HRS/YR)/1000. FY91$

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) NUMBER OF CONTRACTOR ILS PERSONNEL
2.) ANNUAL SALARY - DEFAULT = $170.675/YR

Date - Sept 91

WBS: RELATED PROGRAMS 99x

DESCRIPTION: CONFIGURATION MANAGEMENT 991

CER: # OF GOVT PERSONNEL * $67.452K /YR

SOURCES/COMMENTS:

$67.452K/YR BASED ON $32.32/HR * 2087 HRS/YR - DATA FROM ANNA BUKONT - ANALZED A MIXTURE OF TEN PEOPLE (GM-13, GM-14, G-15. FY91$. (GOVT OH NEVER INCLUDES PERSONNEL AND OTHER COST).

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) NUMBER OF GOVERNMENT CONF MGMT PERSONNEL
2.) ANNUAL SALARY - DEFAULT = $67.452/YR

Date - Sept 91

WBS: RELATED PROGRAMS 99x

DESCRIPTION: STANDARDIZATION 992

CER: # OF GOVT PERSONNEL * $67.452K /YR

SOURCES/COMMENTS:

$67.452K/YR BASED ON $32.32/HR * 2087 HRS/YR - DATA FROM ANNA BUKONT - ANALZED A MIXTURE OF TEN PEOPLE (GM-13, GM-14, G-15. FY91$. (GOVT OH NEVER INCLUDES PERSONNEL AND OTHER COST).

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) NUMBER OF GOVERNMENT STANDARDIZATION PERSONNEL
2.) ANNUAL SALARY - DEFAULT = $67.452/YR

Date - Sept 91

WBS: RELATED PROGRAMS 99x

DESCRIPTION: CONTRACTOR ENGINEERING TECHNICAL SERVICES (CET) 993

CER: # OF CONTRACTOR PERSONNEL * $160.616K /YR

SOURCES/COMMENTS:

$160.616K/YR - BASED ON THE ACTUAL ENGINEERING LABOR RATE EXPERIENCED BY IN FY90. ($76.96/HR * 2087 HRS/YR)/1000. FY91$

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) NUMBER OF CONTRACTOR CET PERSONNEL
2.) ANNUAL SALARY - DEFAULT = $160.616/YR

Date - Sept 91

WBS: RELATED PROGRAMS 99x

DESCRIPTION: NAVY ENGINEERING TECHNICAL SERVICES 994

CER: # OF GOVT PERSONNEL * $67.452K /YR

SOURCES/COMMENTS:

$67.452K/YR BASED ON $32.32/HR * 2087 HRS/YR - DATA FROM ANNA BUKONT - ANALZED A MIXTURE OF TEN PEOPLE (GM-13, GM-14, G-15. FY91$. (GOVT OH NEVER INCLUDES PERSONNEL AND OTHER COST).

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) NUMBER OF GOVERNMENT PERSONNEL
2.) ANNUAL SALARY - DEFAULT = $67.452/YR

Date - Sept 91

WBS: RELATED PROGRAMS 99x

DESCRIPTION: SYSTEMS EFFECTIVENESS ENGINEERING 995

CER: # OF GOVT PERSONNEL * $67.452K /YR

SOURCES/COMMENTS:

$67.452K/YR BASED ON $32.32/HR * 2087 HRS/YR - DATA FROM ANNA BUKONT - ANALZED A MIXTURE OF TEN PEOPLE (GM-13, GM-14, G-15. FY91$. (GOVT OH NEVER INCLUDES PERSONNEL AND OTHER COST).

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) NUMBER OF GOVERNMENT SYSTEMS EFF PERSONNEL
2.) ANNUAL SALARY - DEFAULT = $67.452/YR

Date - Sept 91

WBS: RELATED PROGRAMS 99x

DESCRIPTION: RETROFIT 9911.1

CER: INPUT: $K/MSL * RECERTIFICATION QUANTITY

SOURCES/COMMENTS: USER INPUTS

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) RETROFIT COST $K/MISSILE
2.) MISSILE DELIVERY SCHEDULE

Date - Sept 91

WBS: RELATED PROGRAMS 99x

DESCRIPTION: INTERMEDIATE LEVEL TRANSPORTATION 9911.21

CER: IF LEVELS OF MAINTENANCE EQUALS 3:
E(COMP.1 WEIGHT * COMP.1 FAILURE RATE) * $.0016K/LB * 2 WAYS * (QTY OF RECERTIFICATIONS + 5.48% UNSCHEDULED MAINT QTY * CUMM INVENTORY QTY)

IF LEVELS OF MAINTENANCE EQUALS 2:
TOTAL MISSILE WEIGHT * $.0016K/LB * 2 WAYS * (QTY OF RECERTIFICATIONS + 5.48% UNSCHEDULED MAINT QTY * CUMM INVENTORY QTY)

WHERE: COMP.1 = G&C, PROP, AND WARHEAD SECTIONS

SOURCES/COMMENTS:

$1.6/LB - GOVERNMENT $/LB FROM NAVSUP LOG, JIM MASTERSON

COMP.x PERCENT FAILURE RATES PER MSL ARE DETERMINED BY THE INPUTS TAKEN FROM THE ATTACHED TABLE. DATA FROM NAVAIR 418 . SCRAP RATE DEFAULTS ARE BASED ON THE TABLES MEAN VALUES PLUS 3 STANDARD DIVIATIONS. FY91$.

5.48% - TOMAHAWK HISTORY

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) MISSILE DELIVERY SCHEDULE
2.) COMPONENT WEIGHTS
3.) COMPONENT FAILURE RATES - DEFAULTS VARY BY COMPONENT
4.) $K/LB SHIPPING COST - DEFAULT = $0.0016K/LB

Date - Sept 91

WBS: RELATED PROGRAMS 99x

DESCRIPTION: DEPOT LEVEL TRANSPORTATION 9911.22

CER: IF LEVELS OF MAINTENANCE EQUALS 2 OR 3:
E(COMP.2 WEIGHT * COMP.1 FAILURE RATE) * $2.50/LB * 2 WAYS * (QTY OF RECERTIFICATIONS + 5.48% UNSCHEDULED MAINT QTY * CUMM INVENTORY QTY)

WHERE: COMP.2 WARHEAD AND PROPULSION SECTIONS (THESE COMPONENTS WILL HAVE TO BE SHIPPED TO THE SUBCONTRACTORS).

SOURCES/COMMENTS:

COMP.x PERCENT FAILURE RATES PER MSL ARE DETERMINED BY THE INPUTS TAKEN FROM THE ATTACHED TABLE. DATA FROM NAVAIR 418 . SCRAP RATE DEFAULTS ARE BASED ON THE TABLES MEAN VALUES PLUS 3 STANDARD DIVIATIONS. FY91$.

$2.5/LB - CONTRACTOR $/LB FROM NAVSUP LOG, JIM MASTERSON

5.48% - TOMAHAWK HISTORY

ANALYST: ROSEMARIE BOLHA

USER INPUTS:

1.) MISSILE DELIVERY SCHEDULE
2.) COMPONENT WEIGHTS
3.) COMPONENT FAILURE RATES - DEFAULTS VARY BY COMPONENT
4.) $K/LB SHIPPING COST - DEFAULT = $0.0025K/LB

Date - Sept 91

CBS ELEMENTS DEPENDENT ON USER INPUTS:

CBS#	ELEMENT
917	MAINTENANCE - ANALYSIS/STUDIES, PLANS, DATA
918	MAINTENANCE - OTHER
927	TECHNICAL DATA - OTHER
933	SUPPLY SUPPORT - SUPPLY, ANALYSIS, PLANS, DATA
934	SUPPLY SUPPORT - OTHER
947	SUPPORT AND TEST EQUIPMENT - OTHER
953	COMPUTER RESOURCES - OTHER
974	TRAINING AND TRAINING SUPPORT - TRAINING DEVICES/AIDS
975	TRAINING AND TRAINING SUPPORT - ANALYSIS, STUDIES, PLANS, DATA
977.2	TRAINING AND TRAINING SUPPORT - OTHER
983	ILS PROGRAM MANAGEMENT - PLANS
984	ILS PROGRAM MANAGEMENT - OTHER
9111.3	RELATED PROGRAMS - OTHER

Appendix I--Acronyms

Acronyms

Operation and **S**upport **C**ost **A**nalyze**R**	OSCAR
Naval Air Systems Command	NAVAIR
Cost Analysis Division	NAVAIR 524
Airborne Weapons Logistics Division	NAVAIR 418
Operation and Support	O&S
Material Support Date	MSD
Cost Breakdown Structure	CBS
Multi-platform Advanced Cruise Missile	MAC
Metrology Engineering Center	MEC
Naval Air Engineering Center	NAEC
Naval Ordnance Center	NOS
Naval Ships Systems Command	NSSC
Atlantic	LANT
Pacific	PAC
Naval Ships Weapon Systems Engineering Station	NSWES
Naval Underwater Systems Center	NUSC
Naval Weapons Center	NWC
Naval Weapons Handling Center	NWHC
Pacific Missile Test Center	PMTC
Ships Parts Control Center	SPCC
Navy Support Date	NSD
Weapon Replaceable Assembles	WRA
Department of Defense	DoD
Built-In-Test	BIT
Integrated Logistic Support Plan	ILSP
Concept Studies Approval	Milestone 0
Concept Exploration and Definition	Phase 0
Justification for Major System New Starts	JMSNS
Program Objectives Memorandum	POM
Concept Demonstration Approval	Milestone I
Demonstration and Validation	Phase 1
Chief of Naval Operations	CNO
Commandant Marine Corps	CMC
Engineering and Manufacturing Development	Phase II
Production Approval	Milestone III
Production and Deployment	Milestone III
Production and Deployment	Phase III
Major Modification Approval	Milestone IV
Operations and Support	Phase IV
Initial Operational Capability	IOC
Aviation Supply Office	ASO
Cost Estimating Relationship	CER
Logistics Requirements and Funding Plan	LRFP
Munitions Design Trade/Operation and Support Cost Model	MUNMOD
Weapons Budgeting Model	WBM
Maverick Life Cycle Cost Model	MAVLCC
Operations and Support Cost Model	ONSCOSTS
Program Manager Air	PMA
Request for Proposal	RFP
Operations and Maintenance, Navy	O&M,N
Weapon Procurement, Navy	WPN
System-In-Service-Time	SIST
Mean Time Between Failures	MTBF
Mean Time to Repair	MTTR

Appendix J--Glossary of Key Terms

Glossary of Key Terms

Interim Spare Parts - includes those spare parts required to maintain the initial inventory of spare parts required prior to the Material Support Date (MSD). Therefore, interim spares includes all operating level material items (replenishment spares) required prior to the MSD and safety level stock (initial spares) which are required initially. Costs associated with spare parts are material costs Weapon Procurement, Navy (WPN).

Initial Spares - covers the initial stockage of spares and is covered by the procurement contract.

Fleet Costs (Organizational Level Costs) - are those costs in which the organizational (operator) level facility is the claimant. These costs are incurred by the fleet on the fleet. For example, placing the missiles inside the submarine torpedo tubes, a limited amount of organizational level maintenance such as visual inspections and cleaning, etc. These costs are not charged to the missile system program office.

Operating level - is the quantity of material items required to support normal system operations in the interval between orders and the arrival of successive shipments.[48]

Program Sponsor Costs - are those costs in which the missile system program office is the claimant. Intermediate and depot level maintenance activities such as recertification, supply, contractor support services, transportation from intermediate to depot and from depot to subcontractors and return, etc.

Recertification (scheduled maintenance) - scheduled missile maintenance which is typically determined by the reliability of the life limited components. Typically, missile recertification occurs either every 3, 4, or 5 years. Recertification maintenance as defined by this report includes the 100% testing of the all up round missile and the replacement of the failed work replaceable units. Recertification is completed at the intermediate or depot level maintenance facilities; therefore, recertification is a program sponsor cost. Recertification costs are labor costs Operations and Maintenance, Navy (O&M,N).

Repair - includes the restoration or replacement of the work replaceable and shop replaceable component piece parts. Repair is completed at the depot and/or intermediate level maintenance facilities. Repair costs are labor costs (O&M,N).

Replenishment spares - are the spare parts required during and after the MSD date which are used to replace failed components (SRAs or WRAs). Replenishment spare costs are material costs (WPN).

Safety stock - is the additional stock required to compensate for unexpected demands, repair and recycle times, procurement lead time, and unforeseen delays.[49] Failed SRAs and WRAs are returned to the government, contractor, or subcontractors for repair. There is some associated lead time with this repair or replacement in which the safety stock is used to maintain the replenishment sparing requirement.

System-in-Service-Time (SIST) - is the time frame which is designated between recertification actions. For missile systems SIST is usually 3, 4, or 5 years.

Spare parts - include both shop replaceable components, work replaceable components, as well as, lubricants, nuts, bolts, etc. "Spare parts are those items of supply and replacement which are required for the maintenance, overhaul, or repair of a system or associated equipment".[50] Spare parts are broken down into two categories: interim (which includes replenishment) and replenishment. Spare parts are material costs (WPN).

Transportation - includes both first destination and second destination transportation. First destination transportation is the initial movement of the acceptance tested missile from the contractor facility to the first point of use (ie., fleet) or storage (ie., intermediate level maintenance facility). At this time the government gains official responsibility for the missile system. First destination transportation costs are a one time expenditure covered with WPN funds. Second destination transportation is any transportation required after first destination transportation occurs. For example, transportation of the missile from the fleet to the intermediate level facility is second destination transportation. O&M,N money is used to pay for second destination transportation. Transportation costs are material costs (O&M,N).

Appendix K--Input Questions

OPERATION AND SUPPORT COST ANALYZER (OSCAR)
"INPUT" SECTION

(Input all dollars as base year dollars)
(Check for errors in "input" column!!!)

User Entry

----------BACKGROUND INFORMATION----------

1 FY to Begin Display of the LRFP Output (19xx)._____
2 Output in TY$ = 1, Constant (FY$) = 0....._____
3 Weapon System Name:....._____
4 AUR Missile Cost ($K/unit)....._____
5 Missile Shipping Weight....._____
6 Missile Length (inches)....._____
7 Missile Diameter (inches)....._____
8 Number of Years of Production (Maximum = 15).._____

----------MAINTENANCE----------

9 Levels of Maintenance (2= O/D or 3= O/I/D)...._____
10 At what level of maintenance is AUR first tested during recertification?
(2= Intermediate level, 3 = Depot level)....._____
11 If the levels of maintenance are 3 and if the AUR is tested at the Depot level, what is yearly "I" Maint cost ($K/year)....._____
12 Continuation of question above: Does this "I" cost include repair of any of the components listed in 26-46? So as not to double count (repairs done at I vs repair done at D) put the cost of those I comp repairs here $K/year._____
13 Number of Depots....._____
14 Number of Intermediate Facilities....._____
15 Spare Parts Turn Around Time (MONTHS)....._____
16 System In Servive Time (3,4, or 5 YEARS)....._____
17 Recertification Hours Per Missile....._____
18 Intermediate Labor - Avg $ Per Hour (Loaded).._____
19 Depot Labor - Avg $ Per Hour (Loaded)....._____

20 Mgmt of Spares- NR SPCC Admin Cost ($K)....._____
21 Number of SPCC Items....._____
22 SPCC Item Retention Cost ($K/item)....._____
23 Mgmt of Spares - NR ASO Admin Cost ($K)....._____
24 Number of ASO Items....._____
25 ASO Item Retention Cost ($K/item)....._____

26 Guidance & Control Section Cost ($K/unit)....._____
27 Guidance & Control Section Weight....._____
28 % Fail - See attachment (decimal)....._____
29 Repair Cost ($K/unit)....._____
30 Percent Scrap (decimal)....._____

31 Propulsion Section Cost ($K/unit)....._____
32 Propulsion Section Weight....._____
33 % Fail - See attachment (decimal)....._____

OPERATION AND SUPPORT COST ANALYZER (OSCAR)
"INPUT" SECTION

(Input all dollars as base year dollars)
(Check for errors in "input" column!!!)

		User Entry
34	Repair Cost ($K/unit)	
35	Percent Scrap (decimal)	
36	Warhead Section Cost ($K/unit)	
37	Warhead Section Weight	
38	% Fail - See attachment (decimal)	
39	Repair Cost ($K/unit)	
40	Percent Scrap (decimal)	
41	Wing and Fin Section Cost ($K/unit)	
42	Wing and Fin Section Weight	
43	% Fail - See attachment (decimal)	
44	Repair Cost ($K/unit)	
45	Percent Scrap (decimal)	
46	Container Section Cost ($K/unit)	
47	Container Section Weight	
48	% Fail - See attachment (decimal)	
49	Repair Cost ($K/unit)	
50	Percent Scrap (decimal)	
51	Analysis/Studies, Plan, Data ($K/year)	
52	Other ($K/year)	

----------TECHNICAL DATA----------

	Contractor	
53	Technical Data: Number of Documents	
54	Average Number of Pages Per Document	
55	Percent Mods Per year (decimal)	
56	Hours Per Page for Revisions	
57	Tech Data Labor Rate Personnel ($K/hour)	
	Government	
58	Technical Data: Number of Documents	
59	Average Number of Pages Per Document	
60	Percent Modification Per year (decimal)	
61	Hours Per Page for Revisions	
62	Labor Rate of Tech Data Personnel ($K/hour)	
63	Other ($K/year)	

----------SUPPLY SUPPORT----------

64	Analysis/Studies, Plan, Data ($K/year)	
65	Other ($K/year)	

-------SUPPORT AND TEST EQUIPMENT (S&T)-------

66	Is Depot S&T Maint in Overhead (0=YES, 1=NO)?	

OPERATION AND SUPPORT COST ANALYZER (OSCAR)
"INPUT" SECTION

(Input all dollars as base year dollars)
(Check for errors in "input" column!!!)

		User Entry
67	If no, Investment $K of Depot S&T & Train Eqt.	
68	Additional "I" level investment $K of S&TE Train Eqt (excluding AUR test sets) ($K).....	
69	Qty of Contr O&M,N Supt Persl Per Depot.....	
70	Contr Supt Persl Labor Salary ($K/year).....	
71	Other ($K/year).....	
	---------COMPUTER RESOURCES SUPPORT----------	
72	Software Maint.- LOC/HR.....	
73	Software Personnel $/HR.....	
74	Number of Lines of Code.....	
75	Other ($K/year).....	
	----------FACILITIES----------	
76	Is Depot Fac Maint in Overhead (0=YES, 1=NO)?.	
77	If no, what is cost of "D" facility ($K/year)?	
78	Is "I" Fac Maint in Overhead (0=YES, 1=NO)?...	
79	If no, what is cost of "I" facility ($K/year)?	
	--------TRAINING AND TRAINING SUPPORT---------	
80	Qty of Instructors/year.....	
81	Instructors Salary ($K/year).....	
82	Training Devices and Aids Cost ($K/year).....	
83	Analysis/Studies, Plan, Data ($K/year).....	
84	Other ($K/year).....	
	------------ILS PROGRAM MANAGEMENT------------	
85	Qty of ILS Govt Personnel/year.....	
86	Salary Government ILS Personnel ($K/year).....	
87	Qty of ILS Contractor Personnel/year.....	
88	Salary Contractor ILS Personnel ($K/year).....	
89	Plans ($K/year).....	
90	Other ($K/year).....	
	--------------RELATED PROGRAMS--------------	
91	Qty of Configuration Mgmt Personnel/year.....	
92	Annual Salary onf Mgmt Personnel ($K/year)....	
93	Qty of Standardization Personnel/year.....	
94	Salary of Conf Mgmt Personnel ($K/year).....	
95	Qty of Contractor Engr Tech Service/year.....	
96	Salary of Contr Eng Tech Serv (CET) ($K/year).	
97	Will the CET be reqt after Prod (1=YES,0=NO)?.	
98	Qty of Navy Technical Serv Personnel/year.....	

OPERATION AND SUPPORT COST ANALYZER (OSCAR)
"INPUT" SECTION

(Input all dollars as base year dollars)
(Check for errors in "input" column!!!)

		User Entry
99	Salary of Navy Tech Serv Persl ($K/year).....	
100	Qty of Systems Effectiveness Engr/year.....	
101	Annual Salary of System Effect Engr ($K/year).	
102	Average Unit Retrofit Cost ($K/unit).....	
103	Number of Flight Test Per Year.....	
104	Average Cost Per Flight Test ($K).....	
105	Yearly Missile Attrition (Qty/year).....	
106	Contractor $K/lb to ship.....	
107	Government $K/lb to ship.....	
108	Other ($K/year).....	

--------DEMILITARIZATION AND DISPOSAL---------

109	Number of Years Until System Disposal.....	

User Entry Del Qty	Model Defaults User Entry O&M,N Esc	Input Model Default	Input	User Entry WPN Esc	Model Default
0					
		1.0000	1.0000		1.0000
		1.0225	1.0225		1.3660
		1.0638	1.0638		1.0733
		1.1044	1.1044		1.1104
		1.1452	1.1452		1.1482
		1.1868	1.1868		1.1873
		1.2298	1.2298		1.2277
		1.2744	1.2744		1.2694
		1.3207	1.3207		1.3126
		1.3686	1.3686		1.3572
		1.4183	1.4183		1.4033
		1.4698	1.4698		1.4510
		1.5231	1.5231		1.5004
		1.5785	1.5785		1.5514
		1.6358	1.6358		1.6041
stop		1.6952	1.6952		1.6587
		1.7569	1.7569		1.7151
		1.8207	1.8207		1.7734
		1.8869	1.8869		1.8337
		1.9556	1.9556		1.8960
		2.0267	2.0267		1.9605
		2.1005	2.1005		2.0271
		2.1769	2.1769		2.0961
		2.2562	2.2562		2.1673
		2.3464	2.3464		2.2540
		2.4403	2.4403		2.3442
		2.5379	2.5379		2.4379
		2.6394	2.6394		2.5354
		2.7450	2.7450		2.6369
		2.8548	2.8548		2.7423
		2.9690	2.9690		2.8520
		3.0878	3.0878		2.9661
		3.2113	3.2113		3.0847
		3.3397	3.3397		3.2081
		3.4733	3.4733		3.3365
		3.6122	3.6122		3.4699
		3.7567	3.7567		3.6087
		3.9070	3.9070		3.7531