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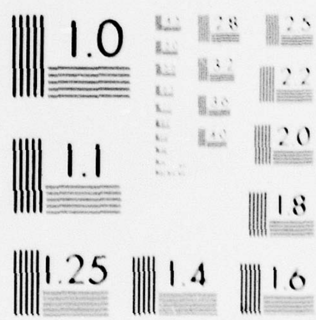

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NAVAL POSTGRADUATE SCHOOL

Monterey, California

THESIS

MAINTENANCE SURCHARGE FOR RANGE USE AT
THE PACIFIC MISSILE TEST CENTER

by

James T. Corbett

September 1979

Thesis Advisor: Robert B. Cunningham

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The Pacific Missile Test Center, PMTC, is utilized by various DOD components to test and evaluate weapons systems. Range facilities include tracking and surveillance radar, telemetry, communication, recording and command/control/destruct instrumentation systems. PMTC is a component of DOD's Major Range and Test Facility Base and is subject to operating under a Uniform Funding Policy.

This thesis investigates the proposal made by PMTC's → over

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Engineering and Design Department that a surcharge system be developed to levy instrumentation maintenance costs on range users. The DOD organization for RDT&E and Weapon Systems Acquisition is discussed in brief. This is followed by a detailed examination of the Uniform Funding Policy and Industrial Maintenance Principles. The PMTC Financial Management System is presented and surcharge implementation problems are identified. A conclusion is made to effectuate a surcharge; and allocation and implementation procedures are introduced.

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MAINTENANCE SURCHARGE FOR RANGE USE AT THE PACIFIC MISSILE TEST CENTER

by

James T. Corbett
Lieutenant, United States Navy
B.S., Merrimack College, 1970

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
September 1979

Author ______________________

Approved by: ______________________ Thesis Advisor

______________________ Second Reader

______________________ Chairman, Department of Administrative Sciences

______________________ Dean of Information and Policy Sciences

ABSTRACT

The Pacific Missile Test Center, PMTC, is utilized by various DOD components to test and evaluate weapons systems. Range facilities include tracking and surveillance radar, telemetry, communication, recording and command/control/destruct instrumentation systems. PMTC is a component of DOD's Major Range and Test Facility Base and is subject to operating under a Uniform Funding Policy.

This thesis investigates the proposal made by PMTC's Engineering and Design Department that a surcharge system be developed to levy instrumentation maintenance costs on range users. The DOD organization for RDT&E and Weapons Systems Acquisition is discussed in brief. This is followed by a detailed examination of the Uniform Funding Policy and Industrial Maintenance Principles. The PMTC Financial Management System is presented and surcharge implementation problems are identified. A conclusion is made to effectuate a surcharge; and allocation and implementation procedures are introduced.

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I. PROBLEM STATEMENT

A. INTRODUCTION

While testifying before the Senate Armed Services Committee on July 23, 1979, General David C. Jones, Chairman of the Joint Chiefs of Staff, stated:

> "We consider it absolutely essential that if the nation accepts the Salt II agreement, it does so with a full understanding that we will be required to undertake a series of important strategic modernization programs in order to maintain strategic parity within limits agreed upon." [Ref. 1, P. 2]

During the same hearings, Defense Secretary Harold Brown said that "defense spending must increase to counter the Soviet military buildup." [Ref. 1, p. 2] This position is emerging as a central theme of the government's effort to win ratification of the treaty, i.e., the need to build new weapons despite the limits in the agreement with the Soviets.

A critical issue facing today's military leaders is the development and acquisition of the weapon systems which are required to meet national defense needs. Spiraling costs underscore the facts that the development and production of modern weapons systems requires a major commitment of the nation's resources and at the same time creates long range commitments for future budget dollars. Weapons acquisition has received public notoriety for well documented cases of cost overruns. It is imperative that new weapons are procurred with DOD management emphasizing that cost effectiveness be a primary management tenet.

Test and Evaluation, T&E, effort is tantamount to an efficient and effective procurement system. DOD policy states that the T&E "commence as early as possible and carry on throughout the acquisition process to assess and reduce acquisition risks and evaluate operational effectiveness and operational suitability of the system being developed." /Ref. 2, p. 3/

A major component of the DOD test and evaluation base is the Pacific Missile Test Center, PMTC, located at Point Mugu, California. PMTC is tasked with providing T&E support throughout the life cycle of weapons system development and deployment. The particular area of interest in this thesis is its mission of providing test range services.

The test range consists of two components, the geographical air space shown in figure 1, and range instrumentation. The instrumentation component consists of radar, telemetry, communications, command/control, computer peripherals, recording, antenna, cryptographic and related equipment and systems necessary to conduct a broad scope of T&E functions. A graphic display of these equipments and their inter-relationships is shown in figure 2.

The greatest share of the maintenance dollar is spent on depot level maintenance, DLM, which is defined as all maintenance functions for range technical systems other than organizational maintenance performed by operating personnel. At PMTC, the DLM program is managed by the Design and Fabrication Department through its Inservice Engineering Division.

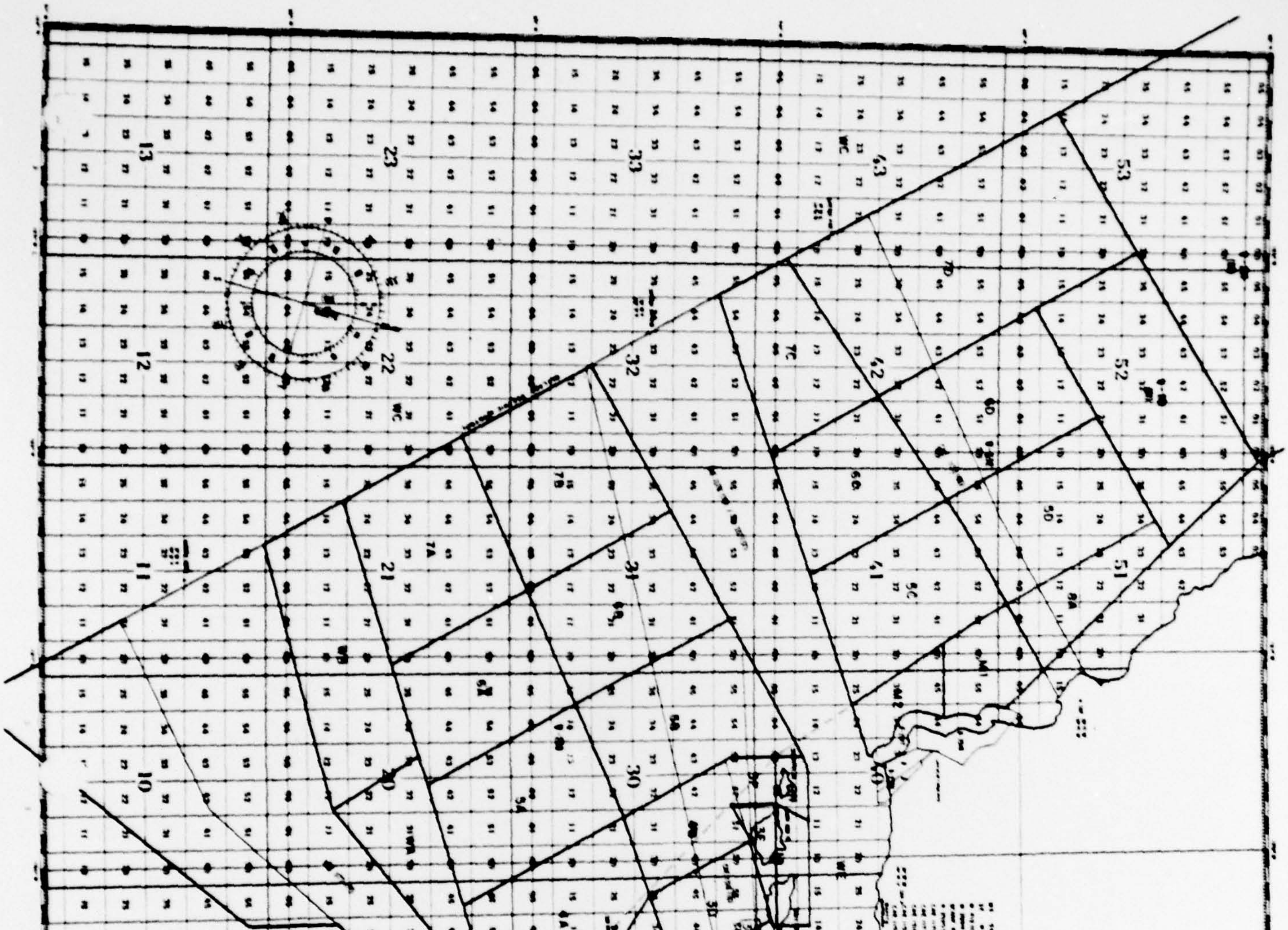
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FIGURE 1

RANGE SYSTEM FUNCTIONAL DIAGRAM

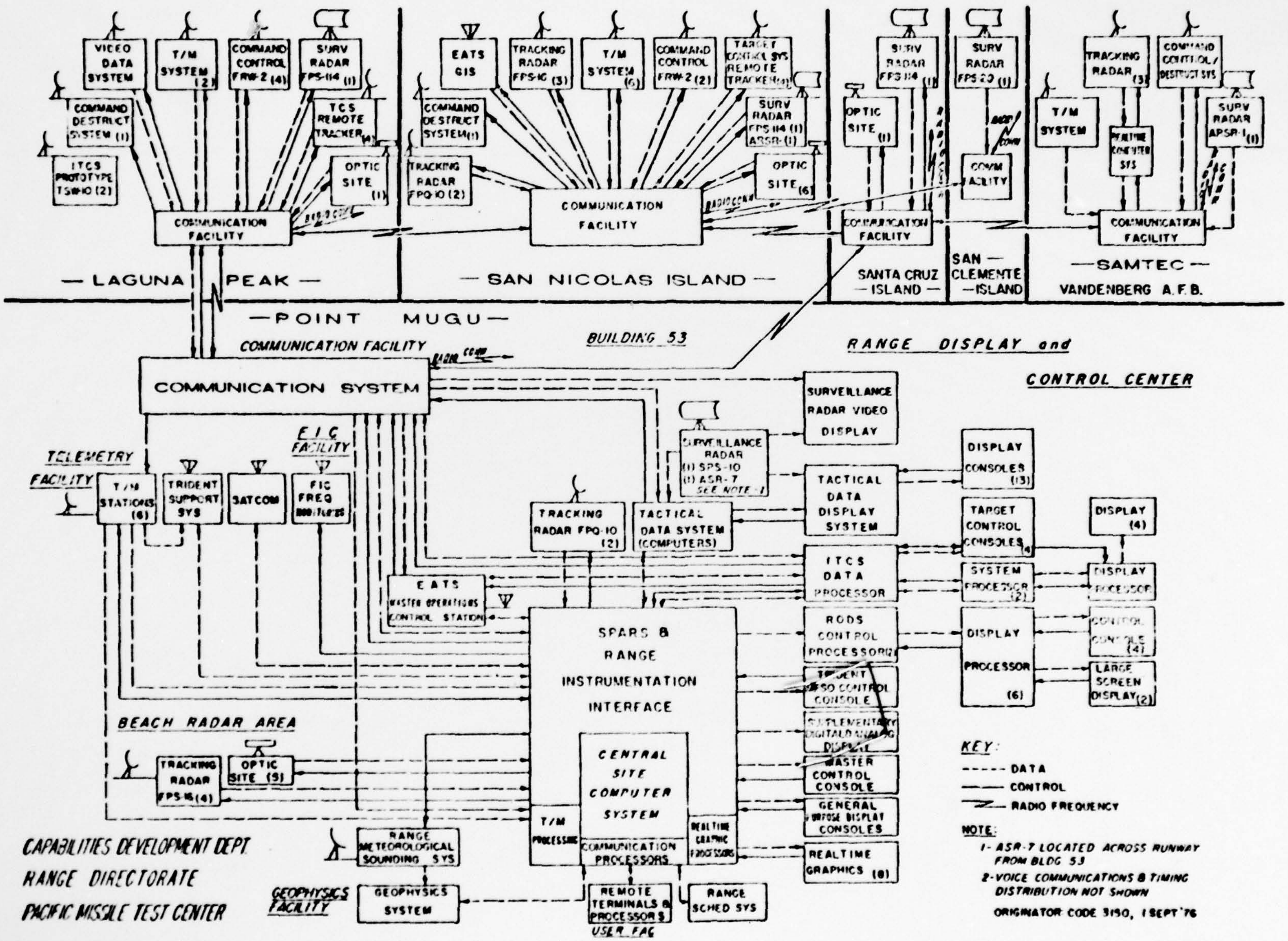


FIGURE 2

It was at the request of that Division Director that this writer was asked to investigate the feasibility of developing a surcharge system to levy instrumentation maintenance costs on range users. The presumption being that maintenance costs are a direct function of range use and as such, should be charged to the various range customers, utilizing an equitable allocation process.

B. THESIS PLAN

Decision making in a large complex organization such as the DOD often requires a thorough analysis of relevant factual and/or theoretical material and a projection of the results of the decision. Initial research into the maintenance surcharge question showed that the decision should be considered with respect to three specific areas; DOD funding policy, industrial maintenance management practices, and financial management principles. If justification is found for the surcharge, the next step would be to evaluate the budgetary effects by utilizing historical and projected data. The final step would include formulating conclusions and making recommendations for implementation.

The research effort consisted of three separate approaches. An extensive literature search was conducted in the areas of maintenance and financial management. A second search was conducted to survey DOD reports, instructions, management guides and policy statements that were relevant to the question. A number of on-site visits were made to acquaint the author with the PMTC operation and to enable him to conduct interviews with individuals throughout the PMTC organization.

C. THESIS OUTLINE

In the second chapter, background information necessary to support subsequent chapters is presented. First, a short history of PMTC is sketched. Then, the DOD and the Department of the Navy Research Development, Test, and Evaluation Program is discussed with emphasis placed on the T&E function. Next, the Defense Acquisition Management System is explained and its relationship with the RDT&E process is illustrated. Chapter 3 investigates the DOD Funding Policy for Test and Evaluation Facilities by looking at background, objectives, issues, and the resultant funding policy. Chapter 4 discusses maintenance management policy, maintenance decisions, performance, control systems, and budgeting and concludes with a summary of concepts. In chapter 5, PMTC's financial management system and potential surcharge implementation problems are presented. Chapter 6 contains an analysis of the surcharge decision and a presentation of an allocation method and implementation procedures.

II. BACKGROUND

A. PACIFIC MISSILE TEST CENTER

At the end of World War II the Navy moved its Pilot-less Aircraft Unit from the Mojave desert to Point Mugu, California, and commissioned the new facilities as the Naval Missile Test Center, NAMTC. The new location was chosen because of its access to a large, open sea area, the availability of instrumentation sites on offshore islands and on 1100 foot Laguna Peak, the mild climate, and the proximity of the growing industrial basin of Los Angeles.

In 1948, a ten year growth period began for the new NAMTC. Laboratory, range, and support facilities were constructed and range instrumentation was installed. The testing program started with land launched missiles and soon moved to air launched systems. Testing grew in sophistication as weapons systems became more complex and a great deal of modern instrumentation and equipment was introduced.

In 1958, NAMTC was designated as one of the six national ranges that would be managed by DOD and provide service to all DOD components and other Federal agencies, in particular those which dealt with the growing space problem. It was recommisioned as the Pacific Missile Range, PMR. Within the next year, the Navy Missile testing function was separated from PMR for administrative and funding purposes and was established as a separate field activity under the then Bureau of Aeronautics. It was commissioned as the Navy Missile Center, NMC. The Point Mugu complex was then composed of three major elements: PMR, NMC, and the Naval Air Station, which was a subordinate command of PMR.

During the next ten years, NMC was the Navy's principle organization for Test and Evaluation of air launched missiles and weapons systems. It played a major role in the development and acceptance testing, production monitoring, and in in-service engineering for deployed weapons systems. NMC was instrumental in the successful development and deployment of Sparrow III, Bullpup, Sidewinder, and Phoenix missile systems.

NMC continued growing during the Vietnam conflict with most of its effort being in direct support of the operating Fleet. As the hostilities wound down, its role somewhat diminished. At the same time, the space program was gearing down its operations with a consequent effect on the workload at PMR. It became apparent that during their growth stages both PMR and NMC had developed duplicate capacities. NMC was capable of providing total weapons testing services with the exception of range resources needed for actual launches, i.e., launch pads and range areas. In the early 1970's there were several consolidation efforts made and in 1975, NMC and PMR were combined to form the Pacific Missile Test Center, PMTC. [Ref. 3]

PMTC's mission is to:

> "Perform development test and evaluation, development support, and follow on engineering, logistic, and training support for naval weapons, weapons systems and related devices; and to provide major range,

technical and base support for Fleet users and other Department of Defense and government agencies. [Ref. 4, p.1]

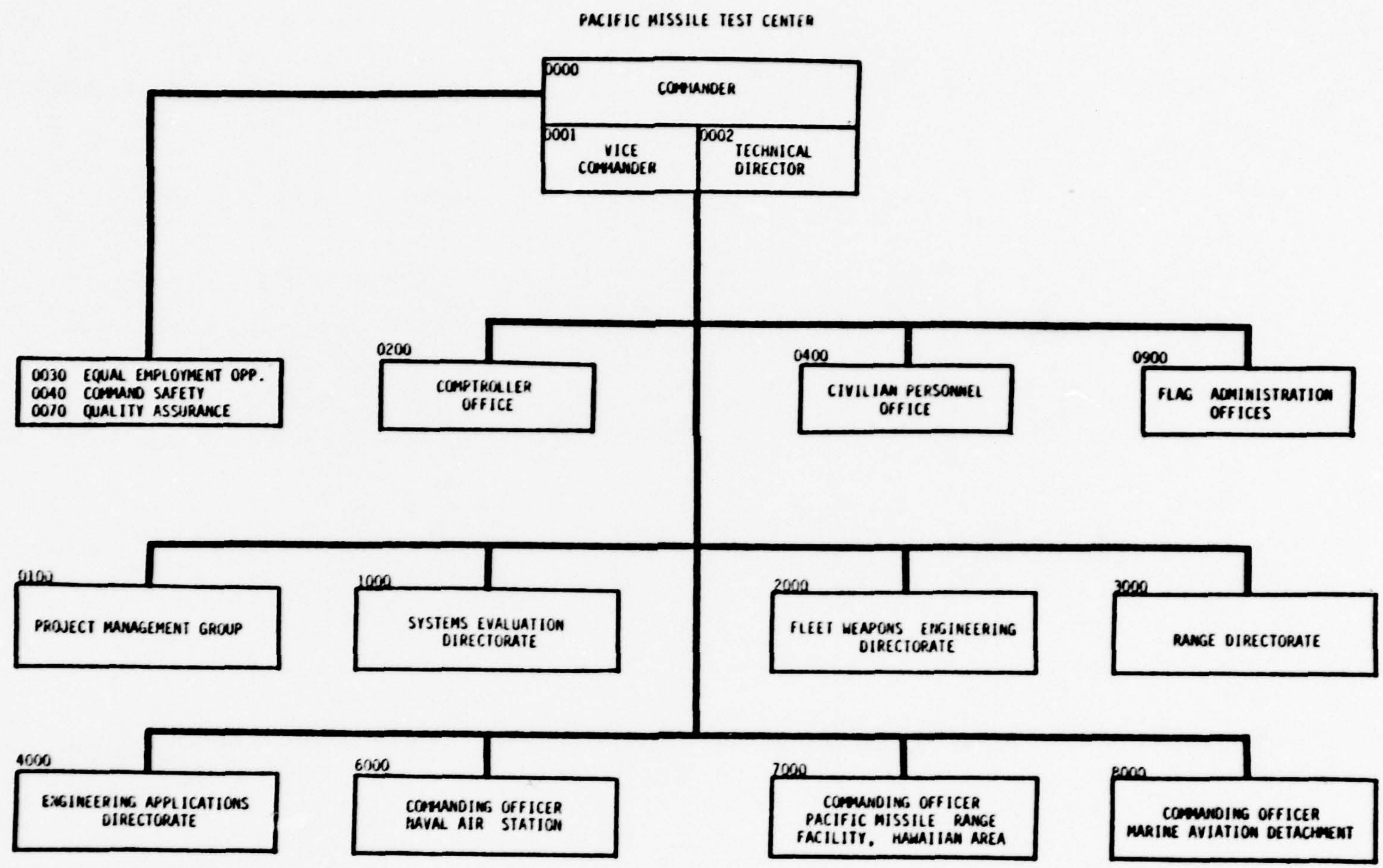
PMTC was organized as a matrix management system with a central Project Management Group executing projects by using functional line components of the organization. The organization chart is shown as figure 3. A brief description of the major organizational components follows.

The Project Management Group is responsible to execute and control assigned PMTC projects. They are involved with initial planning, acceptance, approval, and actual management of the Center's workload. They are tasked with financial management of assigned PMTC funds. In the matrix organization, PMG uses the functional directorates to accomplish assigned projects.

The Systems Evaluation Directorate designs and performs tests to assist customers in determining their T&E requirements. They develop test and evaluation methodologies and techniques. The directorate deals with weapons systems in all life cycle stages.

The Fleet Weapons Engineering Directorate is responsible for managing engineering programs for assigned in-service weapons systems. It is PMTC's single point of entry for in-service engineering projects after the completion of T&E phases and it also provides support service for all elements of Integrated Logistic Support.

The Range Directorate provides range services, related range facilities, and target systems for PMTC projects. It



ACTIVITY	APPROVED	DATE	PREPARED BY	CHART NO
PACIFIC MISSILE TEST CENTER, POINT MUGU, CALIFORNIA	[signature] COMMANDER, PMTC	15 NOV 1978	MANAGEMENT ANALYSIS DIVISION	0000

11ND-PMTC-5400/1 (Rev. 9-75)

FIGURE 3

develops, modifies, and acquires range instrumentation systems. It performs pre-flight operations including operation of range instrumentation systems, operational planning and scheduling, ground and range safety, range clearance and surveillance, and meteorology.

The Engineering Application Directorate provides technical support services and range instrumentation development and support. It designs and fabricates instrumentation, equipment and facilities, and provides meteorology engineering and photographic services. Of particular concern for the purpose of this thesis is its task of managing the depot level maintenance program for range systems and instrumentation.

B. RESEARCH, DEVELOPMENT, TEST AND EVALUATION

RDT&E, as implemented in the Defense Department, is not an end in itself, but rather it is a systematic means for providing the tools for attainment of higher goals relating to National Defense. It is designated as one of the ten programs that make up the total product of the DOD planning, Program and Budgeting System, PPBS, and has been funded with an appropriation amounting to ten percent of the total defense budget over the past ten years.

When Congress passed the DOD Reorganization Act of 1958, the law stipulated that the Office of Director Defense Research and Engineering, DDR&E, be ranked above all other assistant secretaries. DDR&E is the Secretary of Defense's principle advisor on technology and science, the supervisor of all DOD research and engineering, and directs activities requiring centralized management. [Ref. 5, p. 1-5]

The Secretary of the Navy has overall management responsibility for the Department of the Navy, DON. The Assistant Secretary of the Navy for Research and Development, ASN(R&D), has the specific responsibility of managing DON RDT&E activities as well as oceanography and ocean engineering affairs. He has financial management responsibility for the Navy's RDT&E appropriation. Figure 4 shows the DON organization chart with the key members of the RDT&E management team highlighted. The Director, RDT&E, (code OP-098), is assigned to the Chief of Naval Operations, CNO, and is "double-hatted" to provide staff support to ASN(R&D) and to execute RDT&E programs at the operational Navy level.

The CNO manages the operational and support forces and his role in RDT&E is that of a "user" of a potential end product. He determines what capabilities are needed for future operating forces, appraises the military worth of new technology and appraises the various RDT&E output in terms of military value and cost.

The Chief of Naval Material, CNM, manages the Naval Systems Commands and his role in RDT&E is that of a "producer". He translates CNO operational requirements into hardware systems, manages the technology base development, defines the capabilities of advancing technologies, develops detailed plans for RDT&E to satisfy approval requirements in system acquisition, and oversees implementation of the System Commands RDT&E programs. CNM supervises a matrix organization that is used to integrate the RDT&E effort required to develop complex systems. Project Managers are assigned to projects that cross functional areas, system commands or service components. The intent of the organizational structure is to focus the RDT&E effort on output or purpose as contrasted to the functional or discipline approach used in industry and universities.

Planning the RDT&E effort must balance with the whole Navy planning process to provide maximum progress in Naval operating capability that will be required to implement future strategy. [Ref. 5, p. 2-4] That strategy is worked out in the long range planning process developed for direct inputs into the DOD joint planning process. In turn, these planning objectives, generated as part of the PPBS, formulate the DON Five Year Plan which is the approved program by which the Navy is funded.

RDT&E output includes more than hardware. The goal is a total system of operational capability including hardware, support equipment, trained crews and maintenance personnel, facilities, consumables, spare parts, and technical and operating information.

The RDT&E function may be thought of as two processes, one of invention, one of innovation. Invention is concerned with new options, innovation with exploiting options by developing military capabilities that they make possible. On this supposition, the RDT&E program is structured into six categories, with the first two dealing with invention and the remaining four with innovation. See Appendix A for a more detailed classification.

Test and Evaluation, T&E, includes all physical testing, experimentation, and analysis performed during the course of the conception, development, introduction and employment of a weapons system. [Ref. 5, p. 3-7] T&E is performed to generate information needed for development, acquisition milestone decissions, and effective operational utilization.

It is DOD policy that acquisition programs are to be structured, and resources allocated, to ensure that demonstrated actual achievement of program objectives is the pacing function. Obviously, the T&E objectives must bear a meaningful relationship to required capabilities. For acquisition milestones, independent evaluation is mandated. This means that an organization with a vested interest in selling the program can not have unilateral control of the T&E process. The Operational Test and Evaluation Force OPTEVFOR, is the Navy's independent evaluator and is assigned to the CNO. The experimental air squadrons stationed at PMTC are assigned to OPTEVFOR, and are organized to perform operational T&E functions in consonance with PMTC missions.

Despite what the anacronym may suggest, T&E is not simply a follow on to R&D. It begins at the earliest phases of a project with experimental testing of scientific hypothesis through the system's deployment. A T&E program is implemented as a range of events which are all an integral part of the acquisition process to coincide with the decision milestones. [Ref. 6, p. 7]

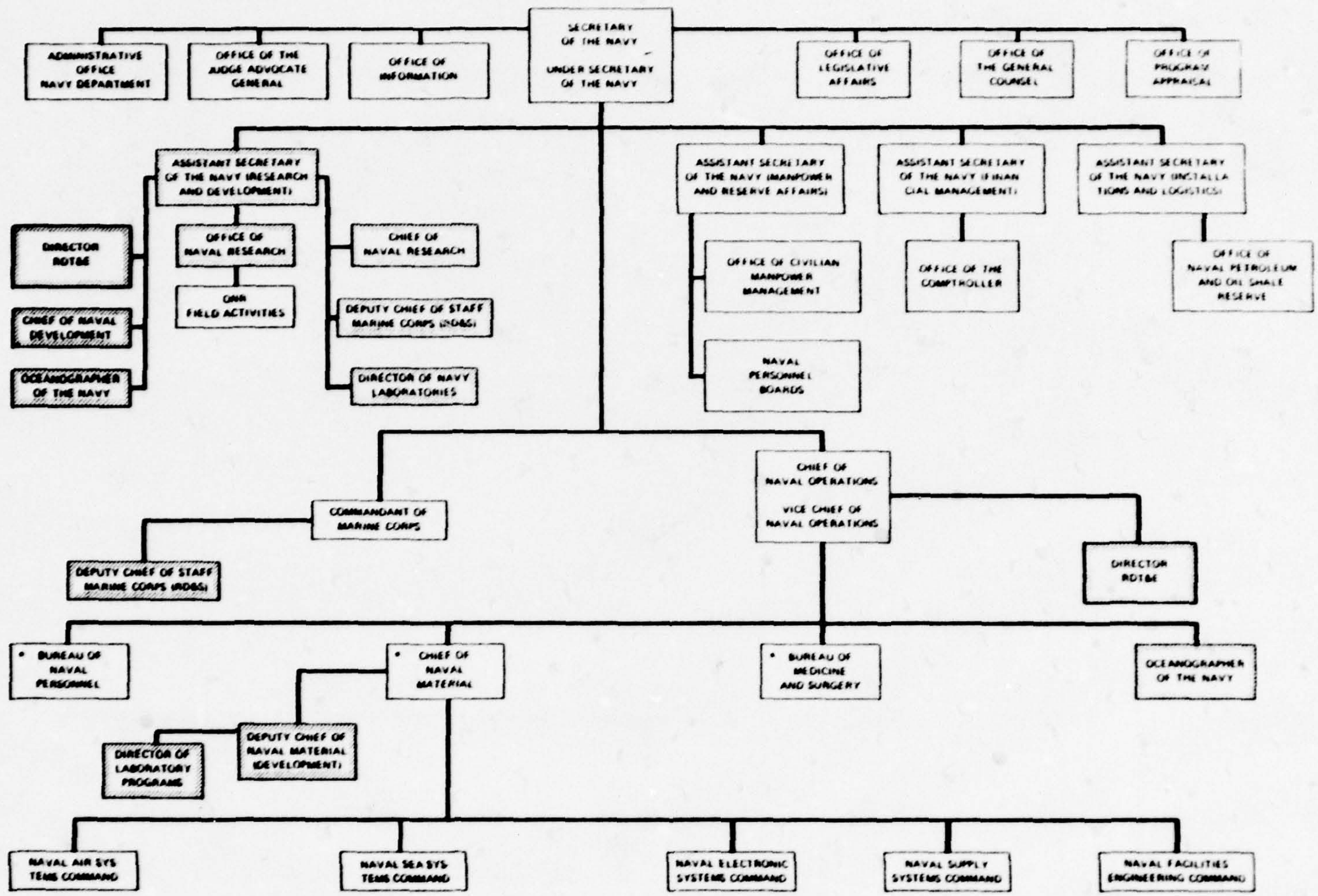
T&E is divided into two distinct parts, Developmental Test and Evaluation, DT&E, and operational Test and Evaluation, OT&E. DT&E is conducted to assess the engineering design and development process and to verify that a system has attained technical performance objectives and met specifications. The purpose of OT&E is to estimate a systems operational effectiveness and suitability, and to attempt to predict how the system will perform when deployed. OT&E is performed by the same type of personnel who will eventually use the system and, therefore, is conducted in an environment that approximates the expected operational environment.

The financial management for RDT&E has the following objectives:

1. Estimate the needs for resources to implement plans.
2. Be able to justify annual resources.
3. Assist in decision making.
4. Assist in optimizing resource utilization by:
   a. Identifying all costs of work performed by both end product and performing activity.
   b. Reporting performance vs. plan to both installation and program management.
5. Minimize duplication in records and reports.
6. Maintain meaningful aggregations and summaries of data.
7. Reduce volume and increase usefullness of reports.

/ Ref. 7, p. 1-4 /

As shown on the DON organization chart fugure 4, the RDT&E management responsibilities are spread throughout the department. The RDT&E appropriation is centrally managed by ASN(R&D). The appropriation includes procurement, development and installation operations authority but does not include funds for military pay. Operating budgets at each command echelon are accompanied by program controls which relate to program elements. Appendix A delineates the program budget structure.



*NOTE: Also responsive directly to CMC for Marine Corps needs

FIGURE 4 - Principal Department of the Navy Headquarters Organization for RDT&E.
(Principals for RDT&E highlighted)

C. DEFENSE SYSTEMS ACQUISITION MANAGEMENT

Traditionally, weapons procurement was managed completely by the individual military components with little influence from DOD. As weapons systems became more expensive, the acquisition mistakes became more expensive There were numerous examples of duplication of procurement effort and many cases of development that continued long after initial test data indicated the project should be cancelled. Furthermore, many weapon systems were developed and deployed without any comprehensive planning to integrate them into an overall strategy. [Ref. 8]

When Robert McNamara was appointed Secretary of Defense in 1960, he recognized the acquisition problem as being symptomatic of the deficient DOD planning process. He instituted PPBS and other complementary systems designed to coordinate the planning of individual military components and to centralize more decision making at the DOD level. In the systems acquisition process, this centralization was carried to the extreme of the Secretary becoming personally involved with working level detail in the infamous F-111 misadventure.

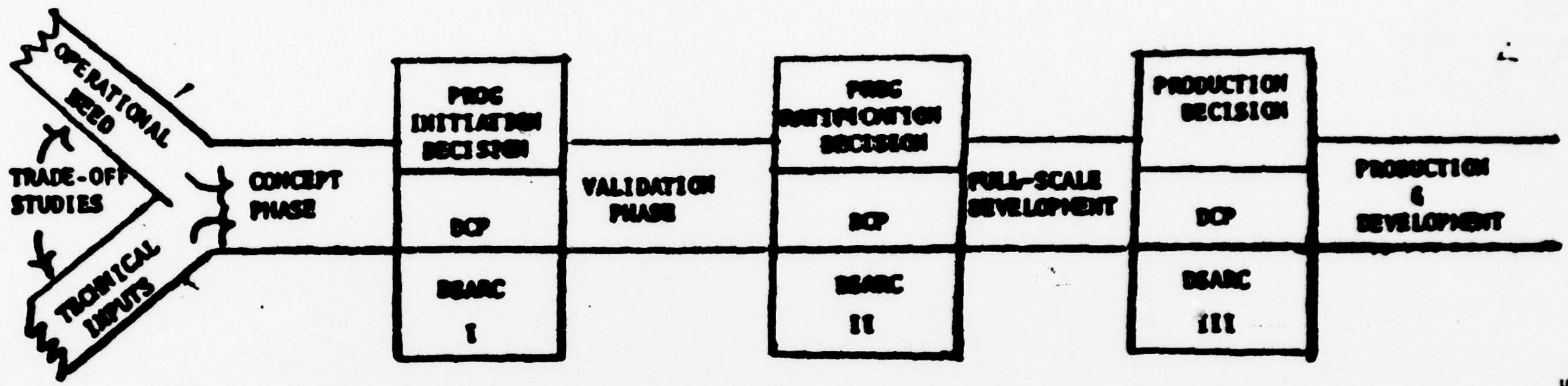
The philosophy reverted with McNamara's successor, Melvin Laird. Laird and his Deputy, David Packard, wanted to reorganize and decentralize systems acquisition so that the DOD components identified needs and the Office of the Secretary of Defense, OSD, established the acquisition policy.

For management purposes, the life cycle of a weapons systems development is divided into four distinct phases, as shown in fugure 5. Major programs are those with an estimated RDT&E cost in excess of $50 million or an estimated production cost in excess of $200 million. [Ref. 9, Enclosure 1] DOD requires that a review be conducted of all major programs to insure that they are ready for transition from one program phase to the next and that the Secretary of Defense makes the transition decision based on the review inputs. The review is conducted with the military component submitting a Decision Coordinating Paper, DCP, that describes the program, its progress, risks, costs, and plans for further development. The DCP is studied by the Defense System Acquisition Review Council, DSARC, at the OSD level and a "milestone decision" recommendation is given to SECDEF. This is commonly referred to as the DCP/DSARC process and is the essence of the acquisition methodology. A more detailed description of its application in an acquisition cycle is given as Appendix B.

Test and Evaluation is critical to the acquisition process. The DCP includes more T&E data at each milestone and identifies critical issues and areas of risk to be appraised in subsequent planned T&E. Results of T&E continually update critical issues. Overviews and test plans are synchronized with decision milestones.

A subsystem of acquisition management is the Selected Acquisition Information and Management System, SAIMS. The basic element of this system is the work breakdown structure,

SYSTEM ACQUISITION PHASE DIAGRAM



DOD DIR 5000.1

APPLIC: RDD Funding Over $50 Millions
Production Funding over $200 Millions
National Urgency
Recommendation by Svc Head or OSD Officials

FIGURE 5

WBS, which categorizes and aggregates acquisition costs to establish a data base for estimating future cost of defense systems. The estimates are used in planning, budget preparation, contract pricing, and program measurement. Figure 6 shows the components of the system and its relationship to the DOD Resource Management System. RMS.

System Acquisition can be thought of as the output of RDT&E, but the two systems are interwoven to such an extent that the idea that one causes the other is not correct. Neither system can exist without the other. A more accurate description of their relationship would be that their combined efforts are required to produce an output that is a total system capability which will optimumly meet its strategic objectives. Figure 7 graphically displays this unique relationship.

SELECTED ACQUISITIONS INFORMATION AND MANAGEMENT SYSTEM

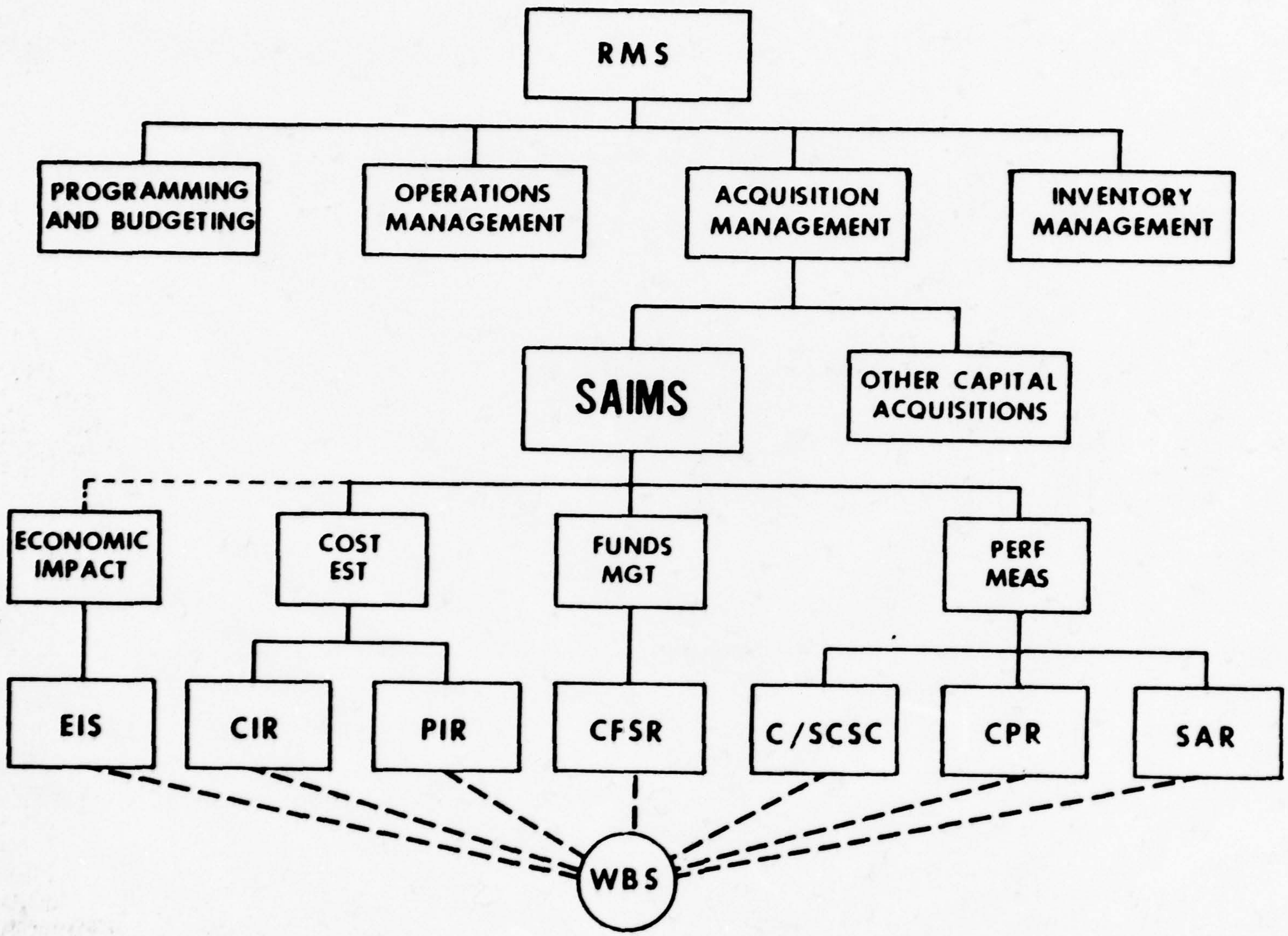


FIGURE 6

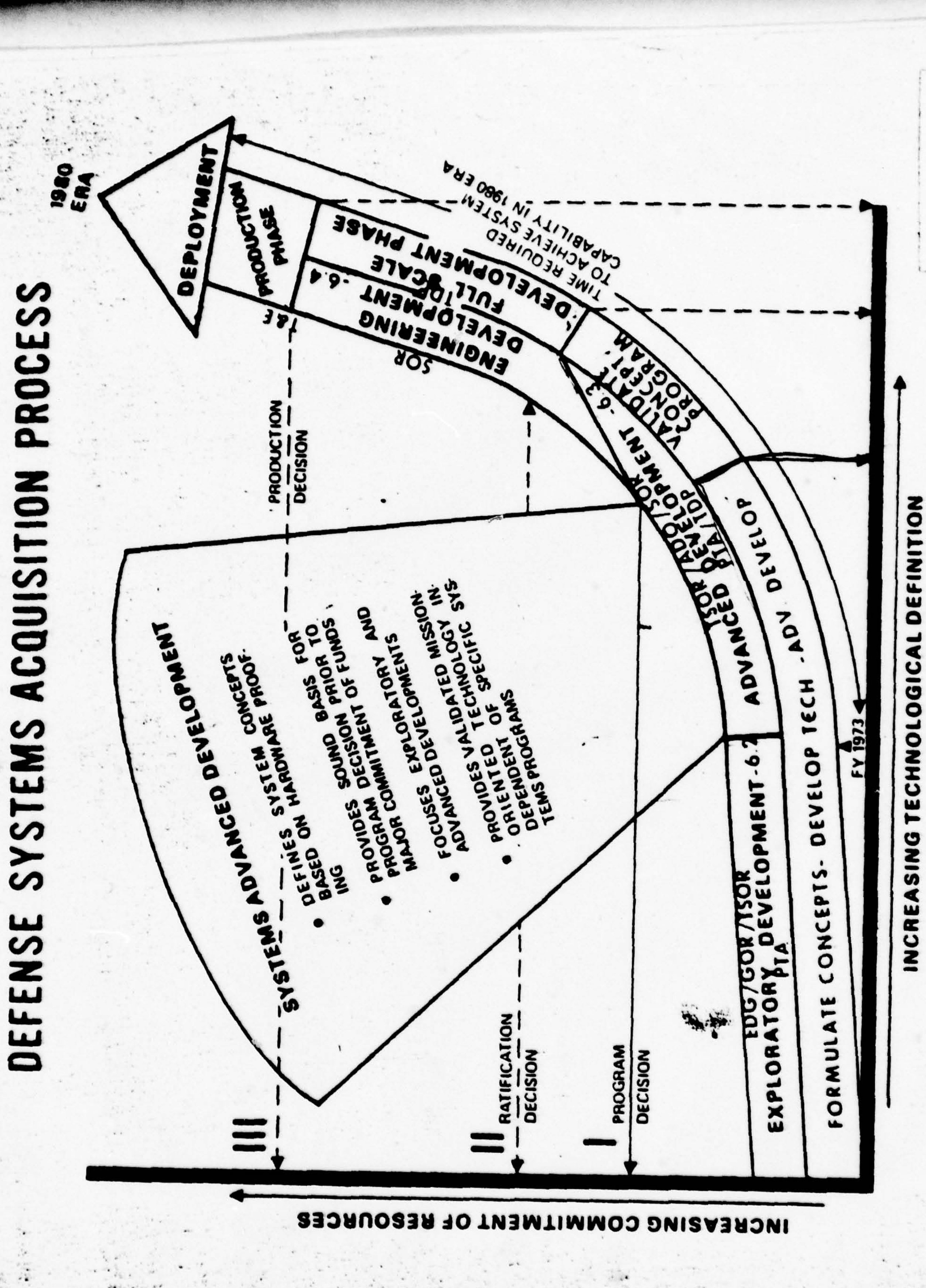

DEFENSE SYSTEMS ACQUISITION PROCESS
SYSTEMS ADVANCED DEVELOPMENT
• DEFINES SYSTEM CONCEPTS BASED ON HARDWARE PROOFING
• PROVIDES SOUND BASIS FOR PROGRAM DECISION PRIOR TO PROGRAM COMMITMENT OF FUNDS
• FOCUSES EXPLORATORY AND MAJOR COMMITMENTS
• FOCUSES EXPLORATORY DEVELOPMENTS ADVANCED DEVELOPMENT MISSION
• PROVIDES VALIDATED TECHNOLOGY IN ORIENTED OF SPECIFIC SYS DEPENDENT TEMS PROGRAMS
III
II
RATIFICATION DECISION
I
PROGRAM DECISION
PRODUCTION DECISION
EDG/GOR/TSOR PTA
EXPLORATORY DEVELOPMENT-6.2
FORMULATE CONCEPTS- DEVELOP TECH - ADV DEVELOP
ADVANCED DEVELOP
TSOR/ADO/SOR PTA/IDP
ADVANCED DEVELOPMENT
VALIDATE CONCEPT PROGRAM -6.3
SOR
ENGINEERING DEVELOPMENT
FULL SCALE DEVELOPMENT PHASE
IDP -6.4
T&E
PRODUCTION PHASE
DEPLOYMENT
1980 ERA
FY 1973
TIME REQUIRED TO ACHIEVE SYSTEM CAPABILITY IN 1980 ERA
INCREASING TECHNOLOGICAL DEFINITION
INCREASING COMMITMENT OF RESOURCES

FIGURE 7

III. FUNDING POLICY FOR TEST AND EVALUATION FACILITIES

A. BACKGROUND

In 1970, President Nixon commissioned a Blue Ribbon Defense Panel to make an intensive study of the DOD to identify problem areas and recommend corrective action. The Panel selected Operational Test and Evaluation as an activity that merited specific attention and assigned a task group to conduct an inquiry into the DOD program.

The group identified a number of critical issues including the question of how T&E should be funded throughout the DOD. They sought to determine if changes in the method of funding would improve the effectiveness and/or the efficiency of the OT&E function.

They found that the funding of test ranges and related facilities was inconsistent throughout the DOD and that there was no standard accounting system used in the financial management of the individual activities. Some activities preferred industrial funding because they felt it forced planning and revealed inefficiencies. Others thought industrial funding was inflexible and that a minimum level of effort funding was necessary to insure T&E responsiveness. The accounting systems used to charge T&E customers for reimbursable services varied and in most cases it was not clear that the direct costs of using ranges were sufficiently identifiable from overhead costs so that any reasonable bases for allocating costs were available.

The task force also found that tests for specific systems were budgeted by the Project Manager while the operation of a T&E facility was funded with various categories of the RDT&E appropriation or with Operating and Maintenance funds. There was no accurate estimate of the total T&E cost of any of the service components. They recommended that the services budget separately for an OT&E program element. [Ref. 10, Appendix F. p. 9] There was some protest from service components that such a change would reduce flexibility in reprogramming restrictions imposed on program element level budget execution.

The task group further concluded that the inconsistencies between services and between ranges had forced T&E customers to utilize a "free" facility vice an industrially funded one. Even if an industrially funded activity had reduced its overhead rate to where it met some sort of efficiency standard, the rate may have been just enough to cause the Project Manager to reduce his test program.

The panel suggested that funding should be uniform throughout the services. A minimum level funding should be provided to maintain capability, provide for "housekeeping", and to pay for indirect costs. In turn, the Program Managers should budget for, and receive, adequate funds to pay for the direct costs of their program as well as any special instrumentation requirements. They also advised that it would be beneficial to have the capability to identify T&E funding requirements by project. They concluded that:

"Range funding and cost accounting were problems that needed high level attention and decisions and could fruitfully be the subject of subsequent study effort." /Ref. 10, Appendix F, p. 11/

In 1971, the DOD conducted an internal study of the Department's RDT&E Base which came to many of the same conclusions concerning funding as the Blue Ribbon Panel had the previous year. In response to these findings, Deputy Secretary of Defense, David Packard, directed that an examination be made of the application of current funding policy at Major Defense Test and Evaluation Support Activities.

The study group was chaired by the Deputy Secretary of Defense (Systems Policy and Information) and its membership was drawn from the Comptroller and RDT&E leadership of the DOD and the component services. The group reviewed funding policy and practices at twenty-six Major Defense T&E Support Activities, examined the strengths and weaknesses associated with alternative funding methods and recommended the revission of the existing policy in order to:

"achieve more uniformity and to encourage greater inter-Service and join use of limited Defense resources available to support test and evaluation." /Ref. 11, p. 1/

The research methodology included an extensive review of existing directives and prior studies, interviews with management personnel at many of the twenty-six activities, and a representative sampling of Project Managers and others who were the major users of those activities.

A general conclusion reached in the study was that the major test and evaluation facilities operated under a set of funding policies which had become exceptionally complex. The complexity was due to in part to suboptimization of the various players in the T&E process. The Commanding Officer of the facility was concerned with supplying the proper mix and quality of services to a wide spectrum of customers. He was constrained by civilain ceiling points, operating budgets, and limited opportunities for instrumentation improvements. The program Manager had to deliver a weapons system that would add to the operating force capabilities while adhering to rigid technical performance specifications, and he had to do this within budget and schedule. The professional test and evaluation community focused on providing the technical skills required to insure that every development project was conducted in a manner that would produce optimum results, again constrained by budget, schedule, and the technology itself. The operating forces which seemed to be habitually tasked with large missions and given scarce funds, often attempted to satisfy training requirements on an available, relatively inexpensive, T&E function. The Congress, as overall appropriator of funds was dually concerned with total cost of the weapon system acquisition and the operating costs of the T&E support facilities. Finally, the Office of Management and Budget was worried about national demands on scarce resources. /Ref. 11, p. 95/

The funding policy for RDT&E has been established by two DOD Instructions, 7220.24, "Accounting for Research and Development", and 7220.5, "Research and Development Program Budget Costs-Definitions". The policy applied to most of the major T&E support activities, but it allowed flexibility to provide various amounts of institutional funding where the managing component thought appropriate. This flexibility led to variations in financial management of individual activities which ranged on a continuum from total institutional funding with resultant "free" services to users, to industrial funding where users were charged all direct, indirect, and general overhead costs.

The study found evidence that these variations in funding policy and user charging systems had forced customers who had planned valid, required T&E at a given activity, to either cancel a test or test in a cheaper, but perhaps less effective manner. Other reactions were to limit the test itself which risked producing inaccurate or invalid conclusions, or even deferring a test in hopes that the funds might become available. [Ref. 11, p. 71] This was obviously not in consonance with the overall RDT&E/Systems Acquisition goal of providing the best weapons system possible for the least amount of expenditure.

B. INSTITUTIONAL VERSUS USER FUNDING

Institutional versus user funding was the basic question to be answered in formulating a new funding policy. Should users of T&E support facilities pay for the total costs of all services provided? Should the institution providing the service, the T&E activity, be totally funded through the service component chain of command? Or more practically, should a new policy include a combination of user and institutional funding, weighing the fact that funding patterns influence motivation by having a pronounced effect on a manager's "report card".

Proponents of <u>institutional funding</u> cite the following:

1. The costs of operating and maintaining a test facility are not a direct function of workload and institutional funding ensures a minimum level of T&E capability.
2. It helps assure the proper amount of testing is being done.
3. It gives the Commanding Officer of the T&E activity the authority he needs to complete his mission.

Opponents of <u>institutional funding</u> counter these advantages with equally valid arguments:

1. It's immediate economies may lead to a user choosing the "cheapest" T&E support available while ignoring vital technical support differences.
2. It could lead to the OSD, instead of the Military Departments, managing the T&E facilities.
3. It tends to be more vulnerable to undefinitized budget cuts than specific program developments.
4. It does not motivate a T&E activity to tailor their support capability, which leads to duplication throughout the T&E base.

As a different side of the same coin, proponents of <u>user funding</u> list its advantages as:

1. It encourages cost consciousness in the project management process.
2. It enables the PM to make cost-effective decisions in balancing resources between testing and other aspects of his program.
3. It gives the PM the budgeting authority to match the program charter responsibility.
4. It clearly identifies costs to specific programs and is a step closer to the goal of ful disclosure for total weapons systems costs.
5. User funding highlights overcapacity in the T&E base in accordance with the laws of supply and demand.
6. It is advantageous in light of DOD budgeting experiences that show it is easier to justify funds to finance a specific project than to finance an overhead activity like a T&E facility.

/Ref. 12, p. 16/

Both funding policies can be defended using valid arguments that support the position in terms of effectiveness and/or efficiency of both the T&E and the PM.

C. OBJECTIVES OF A NEW FUNDING POLICY

When Secretary Packard commissioned the study group, their charter reflected his concern for the cost and performance problems in the acquisition process cited in Chapter two of this treatise. He specified that a primary objective of any new funding policy would be that it would not prohibit the type or amount of T&E a development system required from being accomplished. This seemed to be the most evident symptom of the underlying funding problem.

Through their research effort, the study group developed a set of criteria to evaluate funding proposals that complemented and added to the primary objective. The criteria were principally aimed at alleviating the complexity problems discussed earlier in this chapter.

They determined that a funding policy should recognize the Project Manager's role as established with development and acquisition policy, and assist him in managing the resources to carry out his responsibilities. It must enable the T&E activity Commander to fulfill his mission of providing required support in an environment that is constantly changing in response to national defense policy and/or technology. It ought to recognize the requirement for a measure of stability in the T&E capability that developed over a long period and has a high probability of use in the future. It needs to serve the needs of Congress and OMB.[36]

The study group was also pragmatic in their view of actual implementation of any new policy. They set further criteria that required any new funding policy to be saleable to those groups that would use it, be clear and simple in application, and should not force fit uniformity.

Finally, it addressed the standards of effectiveness and efficiency as follows:

> "It should encourage those responsible for test support to make cost effective decisions concerning the continuance of the activity's level of capability, and the efficiency of their operations. It should encourage project managers and other users of test facilities to make cost effective decisions relating to total weapon system development costs. It should encourage managers in the field activity level to keep their costs at the lowest level compatible with good service to their customers. It should reinforce meaningful, cost effective relationships and dialogue between the activity manager and the user/customer/test sponsor." /Ref. 11, p. 42/

The concept of uniformity of a funding policy among T&E facilities deserves more specific attention. Lack of uniformity distorts cost comparisons between projects. A hypothetical case might involve the development of two similar weapons system capabilities which are utilizing different T&E activities, one institutionally funded, the other industrially funded. If a milestone decision is to be made for a single full scale development based on total costs to date, inter alia, then the wrong decision could be made based on an incorrect cost total. Furthermore, a Project Manager is often in a position during the program budget execution, where scarce funds must be allocated for testing and also for other high priority development requirements such as a contract modification. His immediate solution may be a "cheap" test that is less than optimum when looking at total system development. Finally, nonuniform funding inhibits inter-service use of the T&E facilities. A Navy PM may need to use an Air Force T&E facility which has the expertise to supply support peculiar to the requirements of the Navy's system development. Beyond inherent parochialism, the PM may balk at paying for the test if he could obtain similar, though for less valuable, T&E support at a Navy sponsored activity, which did not charge Navy users.

The study group considered four alternative funding policies:

1. User funding of direct costs at all twenty-six T&E support activities.
2. User funding of direct and some indirect costs at all twenty-six activities.
3. User funding of at least direct costs at all except those designated national ranges.
4. Reaffirm current policies.

It selected the first alternative of user funding direct costs and the policy was implemented in FY75.

A closing caveat listed in their findings was:

> "No solid evidence was found to prove either institutional or user funding significantly inhibits legitimate and valid testing or that the T&E objectivity is affected by funding policy." /Ref. 11, p. 99/

D. MANAGEMENT OF THE MAJOR RANGE AND TEST FACILITY BASE

The major Range and Test Facility Base, MRTFB, is comprised of twenty-six facilities, listed in figure 8, and is considered a national resource. The facilities are managed by the Under Secretary of Defense for Resources and Engineering, DUSFR&E, through the service components. DOD provides policy direction and guidance, insures capability, and attempts to achieve optimum utilization. The cognizant service component plans and budgets for facility costs and funds indirect costs. The activity commander is tasked with planning for current operations and future development. "The entire spectrum of test resources is viewed with the intention of satisfying total DOD requirements with minimum duplication." /Ref. 13, p. 59/

Defense policy for the use, management and operation of the MRTFB is delineated in DOD Directive 3200.11, dated June 18, 1974. It designates DUSDR&E as the cognizant official to review annual budget and apportionment requests in assessing range operations and resource needs. It tasks the Service Secretaries with defining specific missions of the activities, programming and budgeting, and providing for the acquisition of range instrumentation.

Nineteen of the twenty-six major DOD ranges, including PMTC, operate under the Uniform Funding Policy established in FY75 because of their potential for multi-service use.

The specific budget responsibilities at the OSD level are management and control of the joint testing appropriation, review of all MRTFB appropriations encompassing eighteen RDT&E program elements, and monitoring the T&E conducted for major acquisition programs. In the FY78 budget, requests for T&E related activities in all appropriations were estimated to be 2.7 billion dollars. /Ref. 13, p. 63/

MAJOR RANGE AND TEST FACILITY BASE

U. S. Army

White Sands Missile Range
Kwajalein Missile Range
Yuma Proving Ground
Dugway Proving Ground
Electronic Proving Ground
Aberdeen Proving Ground
Aircraft Development Test Activity

U. S. Navy

Naval Air Test Center
Pacific Missile Test Center
Naval Weapons Center
Naval Air Propulsion Center
Atlantic Undersea Test and Evaluation Center
Atlantic Fleet Weapons Training Facility
Naval Surface Weapons Center
Naval Torpedo Station

U. S. Air Force

Space and Missile Test Center
Satellite Control Facility
Arnold Engineering Development Center
Tactical Fighter Weapons Center
Air Force Flight Test Center
Armament Development and Test Center
Air Defense Weapons Center
4950th Test Wing

FIGURE 8

E. SUMMARY

Test and evaluation is an integral part of the systems acquisition process. The payoff of effective, efficient T&E support is maximum military capability using minimum defense dollars. Funding policy does not create resources. The objective of the policy was not to assure that more funds in total would be spent on T&E, but rather that policy which influences the placement of T&E work and how it is payed for, should not prejudice the right technical decisions about testing. It further attempts to provide for cost comparability, elimination of detrimental competition, increasing cost consciousness on the part of both user and the activity, identification of full costs for each development project and improvement in communications between users and support activities.

At PMTC, many of the maintenance costs associated with range instrumentation are a function of range use. A minimum level of maintenance would be required even if the Center had no customers, but the preponderance of operator, intermediate, and all of the depot level maintenance is required because of actual instrumentation use.

The discussion in this chapter demonstrates that the funding policy has objectives which are contradictory, such as eliminating competition while maintaining capability while promoting cost consciousness. In order to meet the objectives that deal specifically with cost considerations, a portion of the maintenance of range instrumentation could in fact be considered a direct cost resulting from range use and could be charged to the user. This may be considered a form of suboptimizing when considering all the objectives of a uniform funding policy, but it may be necessary to meet the majority of policy objectives.

IV. MAINTENANCE MANAGEMENT

A. INTRODUCTION

The paradox of the functions of maintenance and the frequent frustration of its practitioners is cleverly expressed in the following verse.

"I'm not allowed to run the train
  or see how fast 'twill go.
I ain't allowed to let off steam
  or make the whistle blow.
I cannot exercise control
  or even ring the bell.
But let the damn thing jump the track
  and see who catches hell." /Ref. 14, p. 1/

In many organizations, maintenance operates in a negative atmosphere. Its greatest achievements are preventing and correcting production or service breakdowns. In the first case, the results are difficult to quantify and merit while in the second, maintenance is often thought to be culpable for the breakdown. It has been thought of as the spender of funds but the producer of nothing. As production has become more automated and technically sophisticated, the role of maintenance has grown coincidently in importance but is still considered a distant secondary operation compared to the organization's primary production operation.

In this chapter, the importance of the maintenance function and its potential for successful management will be examined. Policy and objectives will be established. The system needed to accomplish the objectives and their composite goals will be outlined. The primary decisions which maintenance management must make are defined and measures of performance used to evaluate those decisions are discussed. The cost control and budgeting aspects of maintenance financial management are presented and the summary relates the chapter discussion to the thesis problem.

B. POLICY AND OBJECTIVES

The essential purpose for the existence of a maintenance activity in any organization is to further the objectives of that organization. The more specific goals which serve that end are functionally or cost oriented. The former include maximizing the availability of equipment for production or service, preserving the value of plant assets by minimizing wear and deterioration, ensuring operational readiness of emergency or standby units, and maintaining the quality of plant assets' output. The cost goal is primarily concerned with achieving the functional goals in an economic manner over a long term. Maintenance is a cost oriented activity with a specific goal to obtain a planned degree of production efficiency at the lowest possible cost. Any maintenance costs must be analyzed with respect to the avoided consequence of failure.

Efforts to control maintenance have lagged behind other management control practices. One causative factor may have been the difficulty involved in developing qualitative analysis techniques for maintenance functions. The increased use of Operations Research in the business community, coupled with top management's detailed interest, has lent the concept of maintenance management a new found respectability.

Terotechnology is another word for resource or life cycle management. It describes a system, or integrated approach to managing physical assets. The term was coined in Britain in the early 1970's and is defined by their Department of Industry as:

> "a combination of management, financial, engineering and other practices applied to physical assets in pursuit of economic life cycle costs; it is concerned with the specification, and design for reliability and maintainability of plant, equipment, machinery, buildings and structures with their installation, commissioning, maintenance, modification and replacement and with feedback on information on design, performance and costs." /Ref. 15, p. 125/

This concept has given rebirth to an old dicipline, maintenance management.

The modern maintenance function may be displayed graphically as shown in figure 9. /Ref. 16, p. 5/ Planned maintenance can be defined as the total of all service functions aimed at maintaining and improving reliability performance characteristics. Prevention activities include inspection, operator and running maintenance, lubrication, testing, adjustments and replacement or removal of elements. Corrective activities involve minor repairs and depot level maintenance. Unplanned maintenance is analogous to breakdown or emergency maintenance.

A basic precept in Terotechnology is that maintenance is less costly at the incipient stage of failure and therefore, it is incumbent on management to maximize planned, and minimize unplanned maintenance. However, there are diminishing returns to the planned effort and the elimination of virtually all unplanned maintenance is cost prohibitive. With unplanned

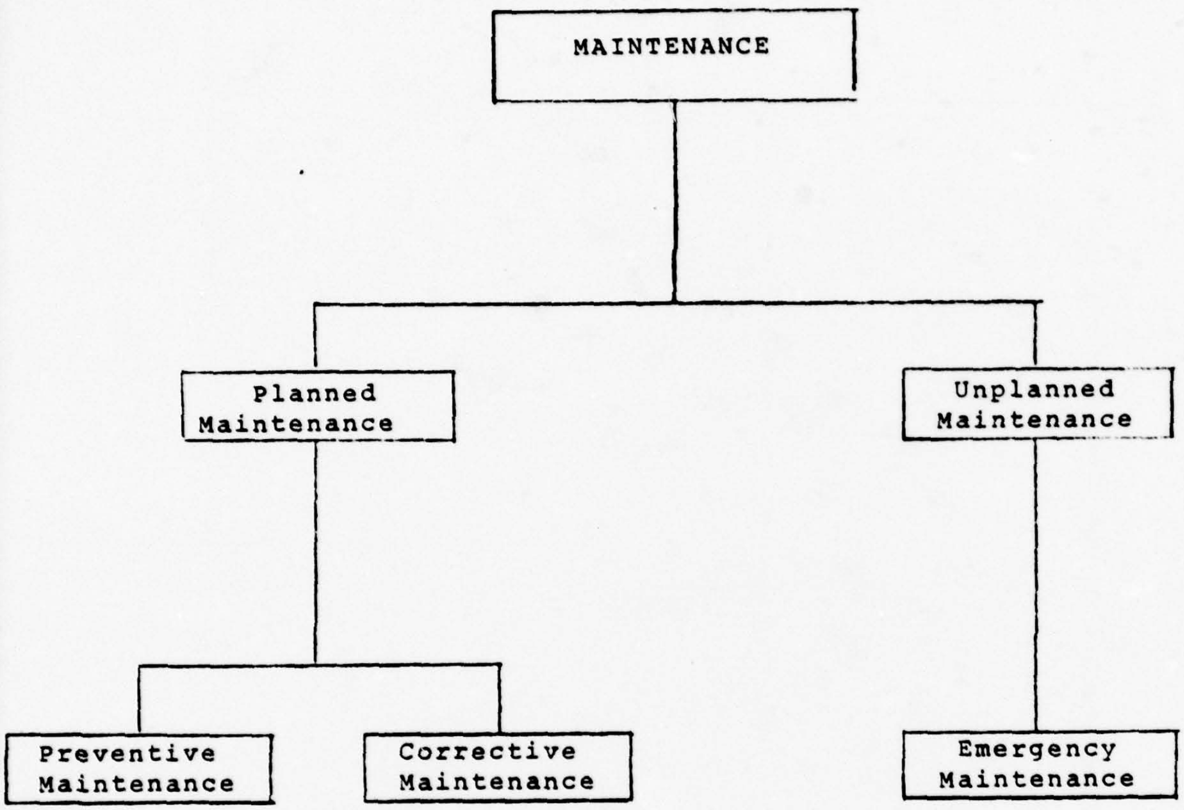

MAINTENANCE
Planned Maintenance
Unplanned Maintenance
Preventive Maintenance
Corrective Maintenance
Emergency Maintenance

FIGURE 9

maintenance, the work demand controls the maintenance program and its organization. Despite the "drama and excitement" often surrounding emergency maintenance, the snap decisions, panic buying, endless revision of priorities and redeployment of labor, all lower the efficiency and effectiveness of the maintenance effort.

Conversely, planned maintenance provides the technical and financial resources to direct and control maintenance operations to meet the objectives of higher overall plant maintenance standards and promotes greater cost effectiveness.

Another category is predictive maintenance. It is a technique which replaces asset components at predetermined points in the operating life, prior to actual failure. This is especially applicable to the electronic components that make up the instrumentation at PMTC. Those components will wear out and fail at a rate which is statistically predictable under normal conditions of usage. Usually electronic equipment does not give warning of eminent failure and there are few reliable means available for inspecting and measuring deterioration. [Ref. 16, p. 68]

C. MAINTENANCE MANAGEMENT DECISIONS

Planning, organizing, and controlling maintenance all involve a series of decisions. Despite the product or service output differences, and the variations in equipments used, most organizations face common decisions in the management of their maintenance functions. The decision environments are usually characterized by some uncertainty, but that does not justify making them in an arbitrary manner. An obvious tenent is that a maintenance decision effects the productive/ service output and those consequences must be evaluated.

An initial determination concerns the balance between preventive and breakdown maintenance. The parameters used in evaluating the problem are the cost of preventive maintenance at various levels of effort and the corresponding cost of breakdowns at those same levels. As shown in figure 10, [Ref. 17, p. 277], the optimal policy is that maintenance level where the total costs are at a minimum. The preventive maintenance functions may range from daily oiling of bearings to prevent their freezing, to the periodic removal of the equipment from service for depot level maintenance.

A second type of decision involves choosing to repair or replace a component, or if failure is complete, the question involves periodic <u>total</u> quantity replacement. A simple example of the latter case would be light bulb replacement in a large facility. Should the bulbs be replaced periodically, in total, or should they be replaced individually, as they fail? Inherent in the decision is a comparison of the cost of replacement, (labor, material, and overhead), with the cost of a failure. A light bulb failure may border on insignificant, but the failure of a command/destruct control system and the subsequent damage to life, property, and Navy public relations caused by an errant missile launch could be colossal.

Spares provisioning is a decision that comprises the extreme policies of providing no spare components with resultant

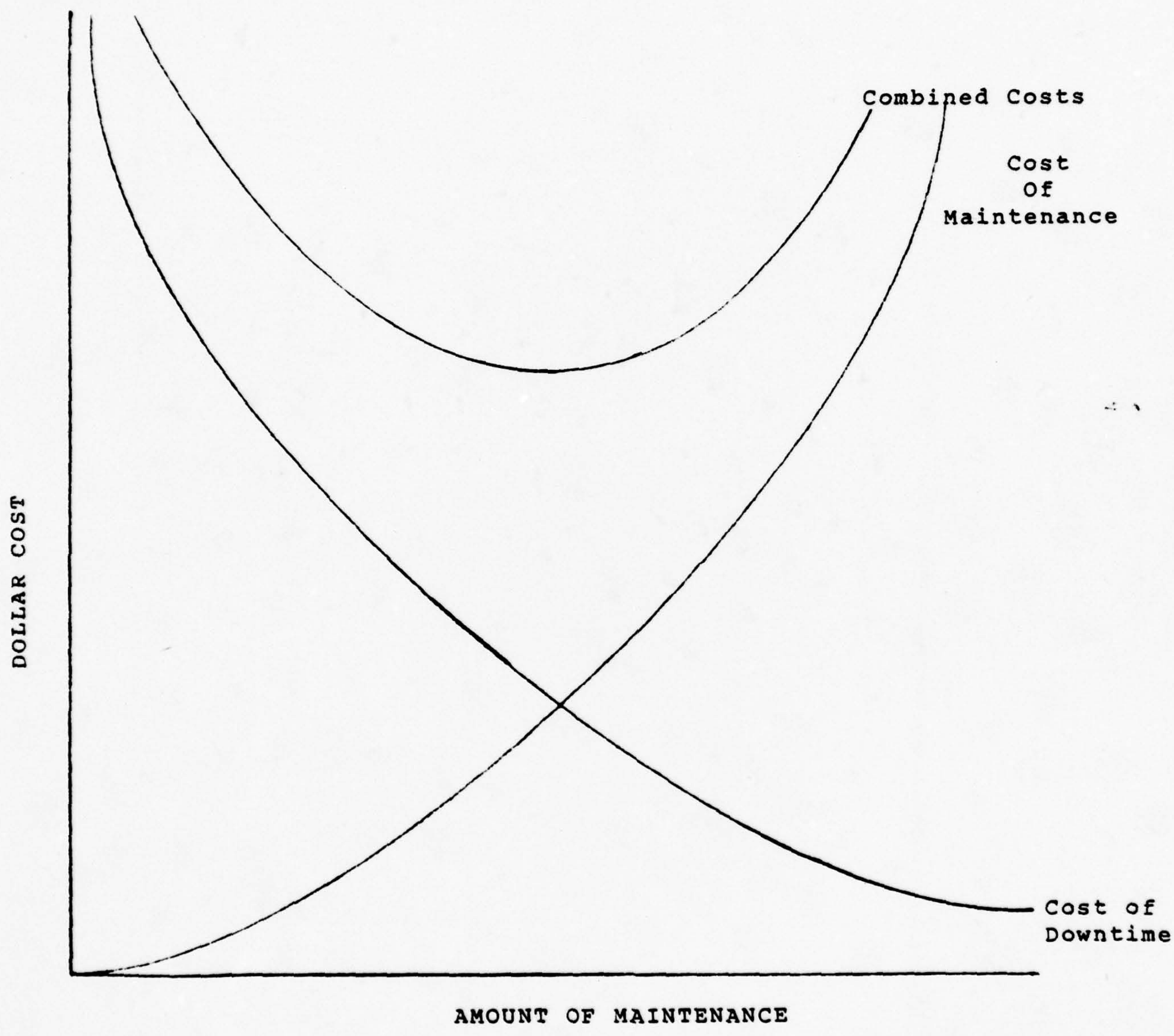

Combined Costs
Cost
Of
Maintenance
DOLLAR COST
Cost of
Downtime
AMOUNT OF MAINTENANCE

FIGURE 10

negligible inventory but long delays and downtime costs, and having a number of complete back-up systems with short downtime but large inventory costs. Interviews with Inservice Engineering Division personnel responsible for the DLM of specific instrumentation systems at PMTC related such a compromise policy. All systems have an inventory of peculiar parts and each has one or two complete critical components which are either crucial to the systems operation and/or have a procurement leadtime that is excessively long. In some cases, spares are held in inventory because the original equipment manufacturer no longer makes those specific component parts. Beyond these peculiarities, there are accepted operations research techniques for managing inventory which enable the decision maker to optimize inventory and minimize overall costs.

Periodic equipment inspection will identify potential problems and reduce breakdowns. An optimal inspection program must be chosen. Figure 10 can be used to show that there is a "level" of inspections where the combination of inspection and breakdown costs is at a minimum. The "level" of inspection would be comprised of two parts, intensity and frequency. Short inspection (maintenance) costs with a corresponding high equipment reliability, with long intervals and less intense inspections having the opposite effect.

Overhaul is a restorative maintenance action which is taken before equipment has reached a defined failure state. In fact, it is a form of preventive maintenance used to reduce the frequency of failures. The overhaul of depot level maintenance function lends itself to analysis using figure 10. The question to be addressed are: How often and to what degree should depot level maintenance be performed?; and, Is maintenance a function of the equipment age and complexity?

A maintenance management system whose purpose is to make the aforementioned decisions is characterized by three phases; planning, execution, and appraisal. The system must support the organization's specific maintenance goals without over-emphasizing procedural policies. However, the system should not sacrifice valid procedural requisites to achieve a flexibility and response to operational requirements that are economically unfeasible.

The Naval Facilities Engineering Command, in its publication "Maintenance Management of Public Works and Public Utilities", list the elements which are germaine to an effective maintenance management system. The initial element is an accurate, detailed inventory which lets management know the quantity and quality of the maintenance requirements. Next, are maintenance standards, which by necessity vary as a function of a particular equipment's use and its relation to the organization's objectives. The system should cause the majority of maintenance work to be generated through inspections which are a controlled, active approach rather than breakdowns which are uncontrolled, passive approach. A simple control point of work reception and work input control from acceptance to completion is necessary for successful execution. Finally, all work should be planned, programmed and scheduled, and the end product must be appraised.

D. MEASURES OF PERFORMANCE

The appraisal function of the management process requires that the actual results of the executed program must be measured against the planned results and the difference must be analyzed. The measurement should be easy to calculate, easy to interpret, should identify poor past management decisions and indicate corrective action.

Performance may be expressed in terms of efficiency. However, developing criteria for measuring the efficiency may be difficult. From the vantage of the operating departments, maintenance is efficient if it prevents breakdowns or if it provides corrective action in a "timely" manner. The controller would consider the maintenance effort efficient if it remained within the budget. There are numerous criteria, which are not independent, and under each, a significant amount of "inefficiency" will exist to permit a sort of maximum "joint efficiency".

In maintenance management, efficiency is the output expressed in terms of cost savings of all maintenance functions, expressed as a percentage of the input cost of those functions, in terms of expended resources. Quantifying either of these costs is difficult at best but impossible without detailed cost data.

Effectiveness is a measure of the difference between actual and planned maintenance performance. Its use requires the establishment of detailed goals and objectives and a methodology for evaluating and comparing planned and actual inputs and outputs.

Maintenance effectiveness can be measured with indices that can be used to show time trends or comparisons between similar functions within or even outside the organization. Some basic indices may be the estimated mean time between failures, the mean time to repair, equipment availability, and maintenance/production cost ratio. /Ref. 15, p. 93/

If indices are used, they should incorporate factors which are under the control of the people held accountable for the performance of the functions the indices are measuring. For example, at lower levels of line supervision the indices may be man-hours/unit or work while at the maintenance superintendent level it might be percent of operating time availability.

E. CONTROL SYSTEMS

Control systems require customizing to fit specific organizations but most utilize common tools such as work requests, preventive maintenance procedures, maintenance scheduling, job specifications, inspection schedules and reports, inventory records and work priority rules. /Ref. 16, p. 56/ Of specific interest is cost control which is dependent on the aforementioned for data, analysis, and implementing corrective action. The control of maintenance costs is the process of obtaining a specified degree of production/service at the lowest possible costs. The control effort may be applied through actual maintenance procedures or through the equipment being maintained. The control target is a result of the previously discussed analysis that determines the minimum total of maintenance and breakdown costs.

The key to accumulating cost data is the job cost card. It should indicate what type of maintenance was performed on what equipment, how much cost was involved in labor, materials, and overhead, and what responsibility center incurred the expense. Data could then be aggregated in summary reports which could put maintenance into perspective as a component of total cost, its relation to direct operational labor, the value of equipment or any other performance measures already mentioned.

The specific elements of cost are equipment, supplies, labor, departmental overhead and plant overhead. Cost control could be applied to the efficient expense of all those input resources. One method of control might involve the distribution of the overhead to operating departments using an allocation base of total dollars spent, man-hours used, or total value of equipment maintained. [Ref. 18, p. 5-9]

Specific cost targets could then be developed using the work standards used in scheduling and measuring work performance. Their objective would be to encourage reduction of actual costs to an "attainable" standard cost. The targets should lend themselves to meaningful aggregation for designated responsibility centers.

F. BUDGETING FOR MAINTENANCE COSTS

The form of the maintenance budget is determined by the organization's requirements as a whole. Maintenance budgets are subjected to fluctuations in both supply (funding), and demand (increased operations), but in most cases, a basic authorization is required to maintain equipment in minimal condition.

Budgeting preparation requires that detailed estimates be made of the components of the maintenance function. This facilitates the frequent adjustments required by allowing for reduction in effort of entire components vice a reduction which may effect parts of various components. In some circles these reductions are referred to as vertical cuts when the component support is being cut as a program and horizontal cuts when cuts are made without regard to any individual system. Careful and judicious application of cuts can prevent a ten percent budget reduction which causes a 100 percent equipment deadline.

Lump sum budgeting for the entire maintenance function, or its few major parts, based on passed experience vice planned action, may satisfy broad organizational financial planning but is unsatisfactory as a budget for maintenance control.

The budget process must specify the responsible individual for various components of the maintenance function. Costs may be allocated to production/service departments for "costing" purposes, but the individual with the authority to decide what maintenance to order must also have budgetary responsibility. Preventive services which are provided continually, such as lubrication, are budgeted as a standard rate per period or as a unit service charge. Those which are rendered on demand are more difficult to budget for. One solution is that the production/service departments be responsible for the number of maintenance calls, and maintenance management for the unit cost of service.

The type of budgets used in maintenance management are classified as fixed, flexible and step budgets:

Fixed budgets make no allowance for variations in planned maintnenance. Maintenance costs are fixed in the short run budgetary period.

Flexible budgets vary with output, which in the production/service department is readily measured, but often difficult to measure in the maintenance department. However, the usual correlation between operational levels of equipment and resultant levels of required maintenance allow for flexible budgeting. It could be useful to develop hourly rates for costing maintenance work but it would be relatively ineffective as a control of maintenance costs. [Ref. 19, p. 68]

Step budgets are essentially a series of fixed budgets developed for a successive range of output expressed in a measure of production/service such as hours. At PMTC, each instrumentation system, such as the FPS-16 radar, could have a budget designated for operator, intermediate and depot level maintenance which would vary as the number of hours of operational activity.

G. SUMMARY

The objective of maintaining the range instrumentation at PMTC is to provide an established level of T&E capability at a minimum cost. Terotechnology offers an integrated approach to resource management which would be of particular significance to the maintenance manager. The minimum maintenance requirement to assure range capability must be institutionally funded because of its independence from range use.

The management decisions essential in planning and control of maintenance are aided by various techniques which optimize functional requisites while minimizing costs. Certain inventory and replacement decisions would require institutional funding because of their "big ticket" nature. On the other hand, depot level maintenance could be funded by applying a surcharge to instrumentation operating hours. If Depot Level Maintenance is scheduled for every 10,000 hours of operation and costs $100,000 to perform, then users could be charged a $10/hour DLM surcharge.

A planned maintenance system will lower repair costs, minimize loss of service due to breakdowns, improve input resource utilization, prolong equipment life and improve cost and budgetary controls. By its nature, planned maintenance requires "front-end" dollars which would initially require institutional funding as a corpus, and could later be recouped with a user charge.

Performance measurement is dependent upon cost data which can be determined without regard to funding source. If user funds were depended upon to meet maintenance standards, a change in activity level could frustrate that goal. Furthermore, corrective action may be difficult to implement if it is dependent on user funding.

Control may be strengthened by grouping maintenance costs as to how they are incurred. A fixed budget would satisfy minimum maintenance requirements and lends itself to institutional funding. A flexible budget should be used to control maintenance costs which management intends to control with operations or some other index of activity and it lends itself to user funding.

The optimal policy of maintenance funding may be entirely institutional. The concept of minimum level of preventive maintenance cannot be dependent on fluctuating service volume. Rising levels of activity obviate increased maintenance costs and it could be suitable to charge users for that increase. The danger lies in becoming too dependent upon user funding for preventive maintenance.

Conversely, an expedient way to reduce maintenance costs is to reduce maintenance. Institutional funding chains are susceptible to this type of thinking in times of unexpected reductions or reporgramming of funds. Maintenance is foresaken for operational requirements because of lack of short term visible damage and managements' desire to meet the requirements of higher authority.

V. PACIFIC MISSILE TEST CENTER FINANCIAL MANAGEMENT SYSTEM

A. INTROUDCTION

Financial management at PMTC is delegated throughout the organization at all levels of supervision. In accordance with Navy policy, there is a comptroller department at PMTC. As specified in the Navy Comptroller Manual, the department is established to maintain an integrated financial management system that assists the line management in carrying out the activity's mission. Through that system the comptroller is responsible for:

> "....Collection of obligation, expenditure, cost and other accounting and operating statistics data; Review of program performance against the financial plan; ...." /Ref. 20, paragraph 012120/

The principles that underly the structure of financial management systems both within the DOD and the private sector are discussed in Appendix C.

B. MODIFIED NAVAL INDUSTRIAL FUND

PMTC is a chartered Naval Industrial Fund Activity, but is classified as a modified NIF activity because some Departments are not operated under the NIF charter. As such, most operations are funded through a revolving, working capital fund that is called a "corpus". In providing services to range users, the cost incurred are charged to and payed for by the corpus. The corpus is subsequently reimbursed for those costs when the range users make payment for services rendered. The user is

CYCLE OF OPERATIONS UNDER NIF FINANCING

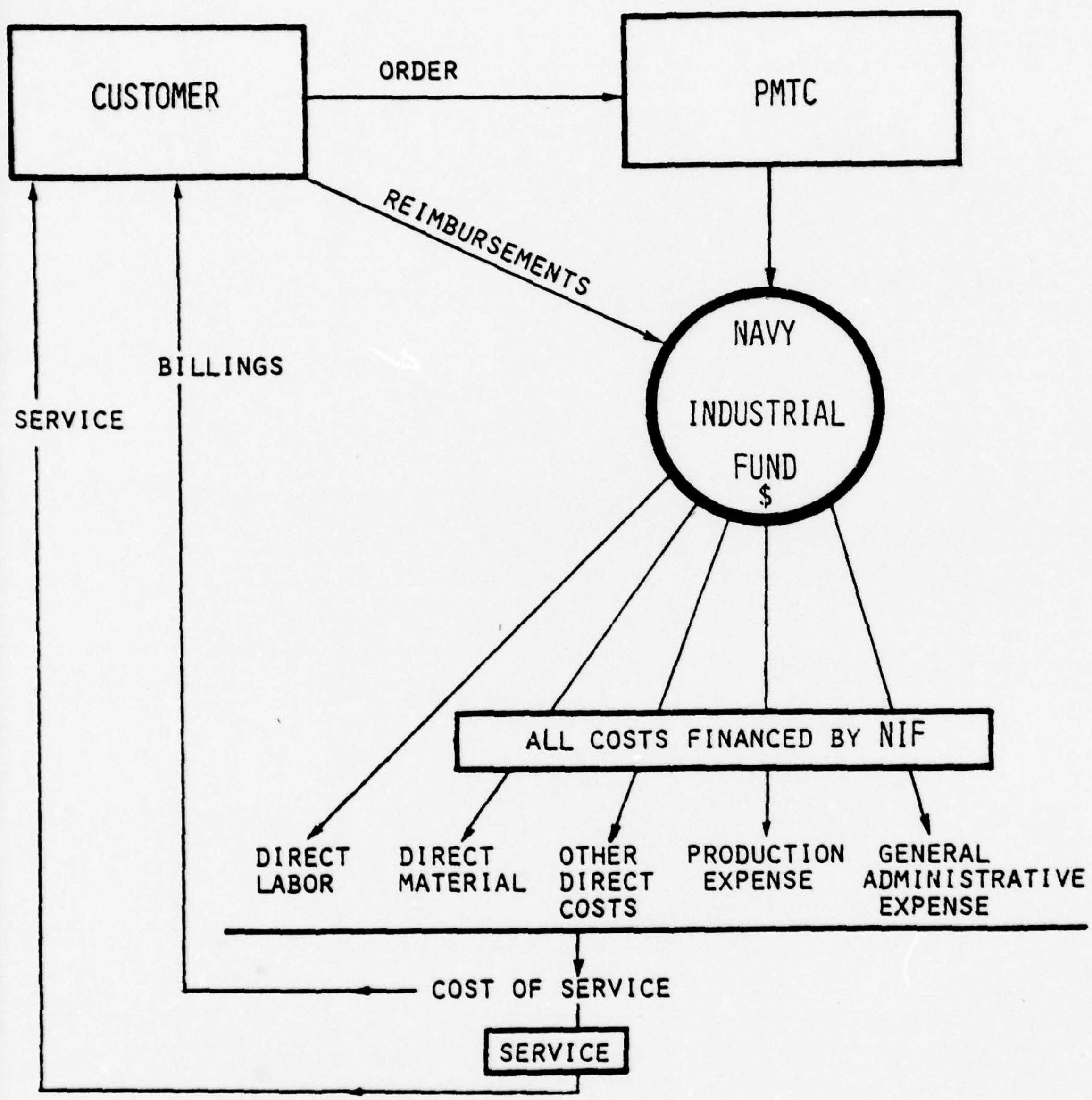


FIGURE 11

billed for the total cost incurred by PMTC in providing the service, including overhead, as work is accomplished. This process is shown in figure 11. /‾Ref. 21, p. 2-10̲7

As stated above, PMTC is somewhat unique in that some of its components are not operated under the NIF charter. The range/test cost centers, which include the Inservice Engineering Division, are considered a part of the Military Range and Test Facility Base, MRTFB, and as such operate under the UFP. These cost centers charge customers only for direct costs. Their overhead is funded institutionally, by the Department of the Navy, under program element 65864N. /‾Ref. 21, p. 2-3̲7 Unlike the NIF, these funds are dependent upon the Congressional appropriation cycle and are subjected to higher level revision in the Planning, Programming, and Budgeting System.

In order to facilitate overall financial management at PMTC, the comptroller has established administrative procedures to assimilate the administration of the range/test cost centers into the NIF environment. Those cost centers are required to budget both direct and indirect costs. The direct are charged in the same manner as NIF charges. The indirect portion is equivalent to the production expenses in a standard NIF cost center and is subjected to the same overhead review and approval process as the NIF cost centers. Unlike those NIF centers, however, the range/test centers indirect costs are funded institutionally.

DIRECT FUNDS ADMINISTRATION CYCLE

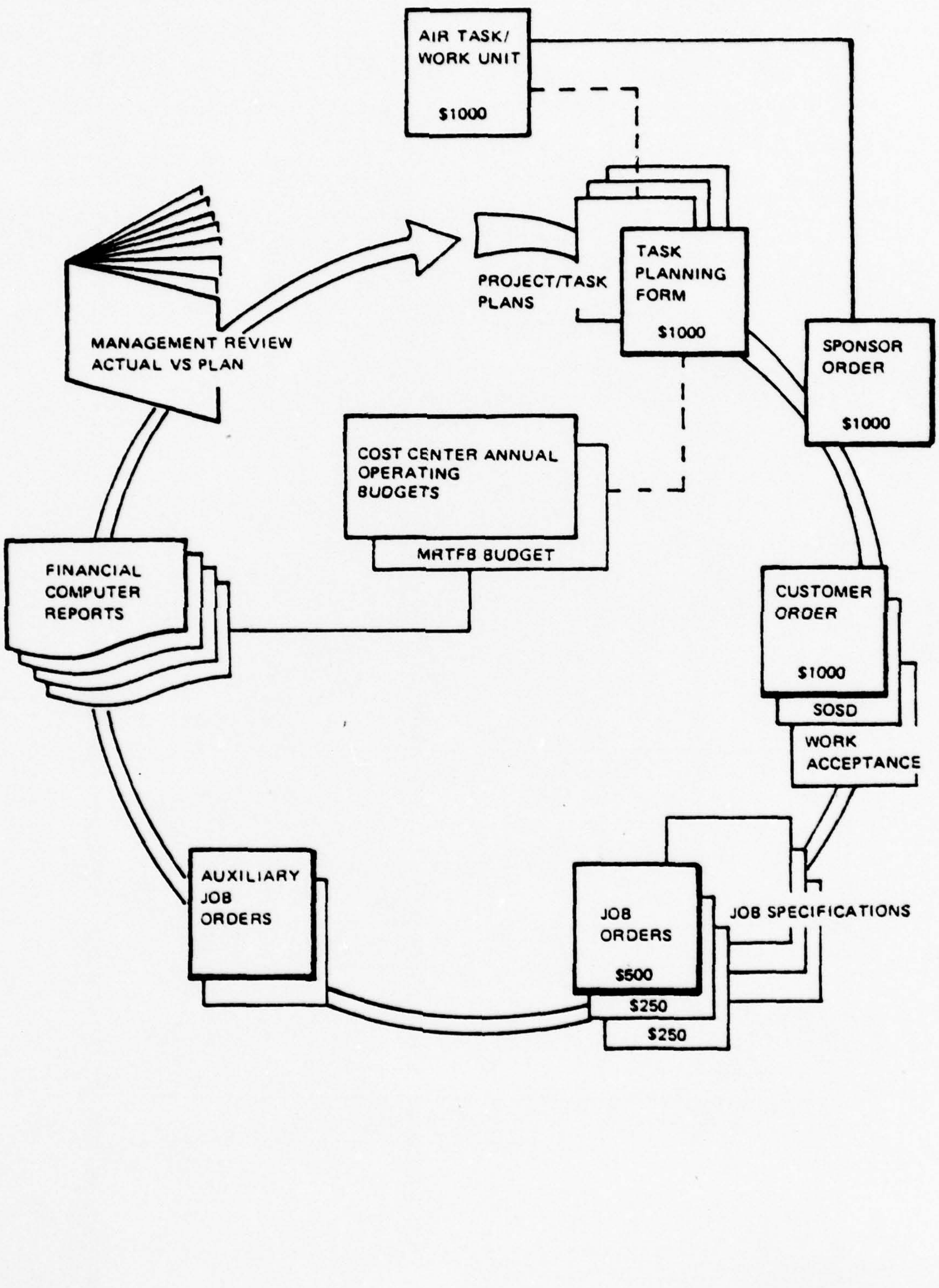


FIGURE 12

PMTC's direct fund administration is a process of:

> "planning, accepting, managing and controlling fund authorizations received or reimbursable orders from external customers requesting work or services to be performed by the Pacific Missile Test Center. Inherent in the funds administration process is the continual review of actual costs versus planned costs at various levels of management." /Ref. 21, p. 3-11/

Figure 12 /Ref. 21, p. 3-5/ illustrates the documentation involved in a life cycle of the funds administration process through the management steps of planning, executing, controlling and evaluating.

C. SURCHARGE IMPLEMENTATION PROBLEMS

Almost any policy implementation would have problems to overcome. This is especially true in an organization as large and as complex as the DOD. Realization of a maintenance surcharge system involves four general areas in which obstacles must be overcome; budgeting, rate development, accounting procedures, and contingency planning.

The DOD budget process requires a minimum of two years between requesting funds and receiving authorization to expend those funds. Forecasting T&E requirements from both the activity and user perspective is exceptionally difficult due to the ever changing technological environment. It is further complicated by budget revisions in the approval stage and budget cuts in the execution stage. Requiring the user to pay a maintenance surcharge for the variable element of DLM costs will aggrevate the existing problem of T&E reimbursable estimates agreeing with user budget submissions. However, these are not new problems and as all the players in the acquisition process develop expertise in utilizing the UFP, they should become less severe. The maintenance surcharge is simply another "direct cost".

Initially, it will be difficult to develop maintenance surcharge rates. Historical data is not aggregated in a conducive manner. An intensive search through existing records, coupled with the high level of expertise and experience of the DLM management group, should provide fairly accurate data with which to calculate the initial surcharges. Subsequently, a reliable data base can be developed to validate future surcharges. Initially, cost estimates will be crucial to successful implementation.

Rate stabilization is used by NIF activities to recover their operating costs by using predetermined rates in billing users for services rendered. The rates remain fixed for a specific fiscal period even though actual costs during that period may be more or less than the applied rate. In accordance with NAVCOMINST 7600.23B, /Ref. 22/, components of the MRTFB operating under DOD's UFP will establish stabilized rates for direct costs for T&E support. A maintenance surcharge would thus be part of a stabilized rate including <u>all</u> direct costs for a specific range instrumentation service.

The accounting procedures used at PMTC are dependent upon the job order cost system for data collection. The maintenance surcharge must be applied through this system. The system is currently functioning under the UFP and is used for collecting and charging direct labor and material costs against the various user programs that are responsible for incurring those costs. The only adjustment required in the system is training the personnel responsible for charging DLM costs. They must be trained to recognize the fixed and variable portions of DLM and charge either the institutional or a user fund.

The accounting methodology used to make the actual cost allocations could work in either of two ways. The first would accumulate costs in a suspense or clearing account for a specified period, probably a month. At the end of the period, the total maintenance costs would be broken into its variable and fixed components and allocated to users. This would not meet rate stabilization criteria. The second system would set the maintenance surcharge rate ahead of time rather than awaiting actual cost determination at the end of the period. This method is prescribed in the rate stabilization policy and is used at PMTC to recover other direct costs by program.

The last implementation obstacle deals with the real world problems of program cancellation and slips in schedule. If a user is funded to carry out a T&E plan and the porgram is subsequently cancelled, the T&E activity should be able to receive those "planned on" reimbursables. This may sound contradictory in the concept of DLM varying with range usage but as a practical matter, a committment to variable DLM, in terms of manpower and materials, must be made well in advance of the planned action date. Therefore, some sort of re-programming alternative must be used to insure the T&E activity receives those funds it is committed to expense.

VI. CONCLUSIONS AND RECOMMENDATIONS

A. ANALYSIS OF THE MAINTENANCE SURCHARGE DECISION

The purpose of all discussion to this point has been to present factual and theoretical information that would assist a decission maker in resolving the issue of whether to charge range users for range maintenance. In this section, that information will be analyzed and a conclusion made concerning the decision.

T&E Support plays a major role in meeting the DOD objective of strategic weapons development and deployment. As an element of the T&E base, PMTC is charged with maintaining a minimum level of T&E capability to support a variety of prospective users. An attendant level of maintenance of range instrumentation is prescribed in accomplishing that end. In managing the Depot Level Maintenance Program, the Inservice Engineering Division insures that the sophisticated electronic and electro-mechancial equipments which comprise the range's technical systems are ready to fulfill their specific missions. Funding is crucial to the DLM Program.

The Uniform Funding Policy,UFP, was instituted after an exhaustive study effort and its concluding objectives are based on sound management principles. The combination of the user program and the T&E activity funding the remaining indirect costs is a practical attempt to motivate both components of the acquisition process into achieving higher echelon goals. Depot level maintenance can be funded within this concept in that the minimum level of DLM required to maintain range capability would be funded institutionally and the DLM required because of range use would be charged to those users.

Furthermore, the surcharge would assist in meeting most of the specified UFP objectives. Cost comparability between user programs would be made with more accurate data and their individual development costs would be more precise. The user would become even more cost conscious with respect to the T&E effort, and communication between the user and activity should improve. One objective which might be frustrated is that of prejudicing test selection because of increasing total user cost. This last problem would be alleviated with proper budgetary planning to increase user funds in response to the proposed policy modification.

The only change required in the UPF is in its definition of direct costs. It is this author's contention that although DLM costs are not traceable to specific users, their variable component behaves like a direct cost. If range instrumentation was not used, the DLM effort would be at that level required to maintain range capability. The associated cost would be fixed and its behavior would classify it as a period cost. Maintenance above that level would increase as some function of range use. Its actual cost would be variable and its behavior indicative of direct costs. Thus the proposal of a maintenance surcharge would include only the variable portion of DLM while the fixed portion continue to be funded institutionally.

A successful maintenance program requires that DLM be planned, programmed, and scheduled. This requires "hard, up front dollar committments." However, by definition, the variable component would require funding only as the volume of usage changed. This would require management attention to ensure that as the hours of range use increased, DLM was <u>replanned</u> to accommodate that increase.

Would the application of a maintenance surcharge provide a logical and equitable balance between the differing responsibilities and motivations of users and T&E activity managers? It would with the proper funding policy change. Initially, maintenance management would be tasked to provide the fixed portion of DLM and would be funded accordingly. Users would receive added dollars within their T&E allotment. From that point on they would be "motivated" by the in-place UFP System that recognizes the complimentary roles of the Project Manager and the T&E activity Commanding Officer. Both user and supplier would make decisions that incurred costs and the responsibility for controlling costs would be shared between them. The user would have no control over fixed DLM costs, but by means of his requests for T&E support would in fact control the quantity of variable DLM. Since maintenance managers would control the resource inputs to the variable DLM, both would control variable DLM costs. Beyond this, overall stewardship would not be altered by a maintenance surcharge.

The budgetary authority for DLM should be given to those organizational components which decide what maintenance will be accomplished. A fixed institutional budget would be required for the fixed DLM, managed entirely by the T&E activity. They would use a flexible budget for the variable DLM. Again, the existing UFP already allows for this division in budgeting for established direct costs.

With control and budgetary authority defined, and objectives established, the performance of users and T&E activity managers would continue to be evaluated with existing measures of effectiveness and efficiency.

A possible negative consequence of depending on users to fund part of DLM is that T&E management may be forced to delay decisions involving reimbursables until they are in hand.

> "Trading institutional dollars that can be expected to materialize, for reimbursable dollars that are only available when, and if earned, puts the T&E facility's financial manager in a position of betting on the outcome." /Ref. 23, p. 17/

There are two key words in the quote. "Expected" is overly optimistic in describing the procurement budgeting process, especially when considering the overhead function of DLM in an overhead activity such as PMTC. "Betting" is a synonym of poor management. Properly detailed planning can provide for alternatives when activity levels vary.

From the users point of view, would they be paying for passed on T&E management inefficiencies? That situation can be avoided by using a proper allocation method, as will be shown in the next section.

In conclusion, a maintenance surcharge would help to better categorize and aggregate acquisition costs and improve the data base used for estimating future acquisitions. It would improve overall RDT&E management by aiding in the identification and segregation of project costs and installation costs. The fixed and variable nature of DLM lends itself to a combination funding policy.

B. PROCESS OF COST ALLOCATION

If variable DLM was traceable to a specific range system user, then a direct charging system could be instituted to recover those costs. On site interviews with the various system managers responsible for DLM revealed that there are no such explicit relationships. This requires that the maintenance surcharge be allocated by some systemic and rational basis dependent on cost behavior.

In the financial management process, allocation is used to distribute or apportion expenses to particular cost objectives that otherwise could not be directly charged. Because there is no explicit relationship between the expense and the cost objective, any allocation system is arbitrary by nature.

The first step in the allocation process is to identify the fixed and variable costs for each individual range instrumentation system. This required using historical cost and operations data to identify the systems cost behavior at various levels of activity. The least squares method of statistical analysis is an accurate way to determine that behavior, an example of its use follows. PMTC does not have the data aggregation required for this analysis so hypothetical figures will be used.

Considering an FPS-16 radar system that has operated for various amounts of total hours during the past six months and has required various levels of DLM, the problem is to separate the fixed and variable portion of DLM costs as a function of operating hours. /Ref. 29, p. 136/

FPS-16 Radar

	Operating Hours/Month	DLM Costs/Month		
Month	X	Y	XY	X^2
Mar	120	600	72000	14400
Apr	100	480	48000	10000
May	140	700	98000	19600
Jun	80	400	32000	6400
Jul	160	820	131200	25600
Aug	140	750	105000	19600
	740	3750	486200	95600

Two simultaneous linear equations can be developed to describe the data:

$$XY = a\ X + b\ X^2$$
$$Y = na = b\ X$$

where

a = fixed cost DLM
b = variable cost DLM
n = number of observations, months
X = activity measure in hours
Y = total mixed costs of DLM observed

Solving the two equations simultaneously be eliminating a and solving for b:

b = \$5.47/hour

Then substituting this value in either of the original equations and solving for a;

a = \$49.49/month

In this manner the fixed cost of DLM per month and the variable cost of DLM per operating hour could be calculated. This example assumed that the operating hour would be a correct allocation base in that it would describe a causual relationship with required DLM. The assumption would have been made intuitively and would have to be evaluated for each range system using historical data to validate the base for implementation. Once the base was established and the variable component of DLM was calculated, then the allocation rate, cost/base, could be determined.

The selection of only the variable cost would be consistent with previous discussion. Allocation of the fixed, indirect, DLM costs would not be beneficial to management because those costs would not be controllable by the end user to whom they would be charged. Decisions made by those range users would not effect the fixed costs of DLM.

To underscore the potential inequity of allocating fixed costs, the following example is offered. Again, because actual data is not available, hypothetical figures are used. Consider allocating fixed DLM costs between two users when actual use varies between budgeting periods. /Ref. 29, p. 618/

	FY80	FY81
Fixed DLM Costs	30,000(a)	30,000(a)
Trident Range Use in hrs.	200	200
Phoenix Range Use in hrs.	200	100
Total Range Ops in hrs.	400(b)	300(b)
Allocation Rate a/b	$7.50/hr.	$10.00/hr.

range users make payment for services rendered. The user is

<u>Year 1</u>

Trident	200 hours @ $7.50 =	$15,000
Phoenix	200 hours @ $7.50 =	$15,000
		$30,000

<u>Year 2</u>

Trident	200 hours @ $10.00 =	$20,000
Phoenix	100 hours @ $10.00 =	$10,000
		$30,000

In the first year, both programs would share the fixed DLM costs equally. In year two, the bulk of fixed DLM costs would be allocated to Trident. This would not be due to any change in activity by Trident but rather by a decrease in activity by Phoenix. The end result would be "penalizing" Trident with increased charges because Phoenix would be "winding down". Again, fixed DLM costs should be funded with institutional dollars.

The variable DLM costs could be more accurately described as a "surcharge" rather than an allocation since PMTC would actually charge the user a set rate per unit of service provided, i.e., dollars/hour of range system use. This surcharge should be determined using budgeted costs to prevent maintenance inefficiencies to be passed on to the user.

A summary of the allocation procedure follows: Identify and maintain the distinction between the variable and fixed DLM costs for each range system. Variable costs should be allocated at a budgeted rate according to an established base of activity measurement (probably system hours of operation). Fixed costs should be incurred to provide capability and should not be allocated. [Ref. 24, p. 61]

FIGURE 11

60

C. IMPLEMENTATION PROCEDURES

The initial step in implementing a maintenance surcharge system will require final approval from the Office of the Secretary of Defense. Confirmation would come in the form of a revised DOD Directive, 3200.11, which establishes policy for administering the MRTFB. The chances of approval will be greatly enhanced by actively seeking concurrent endorsement of the proposal from other components of the MRTFB. Obviously, the previously cited principles for RDT&E within the Navy and DOD must be convinced of the proposals merit as outlined in this treatise. The request must be participatory in that users must be given an opportunity for input.

Once initial approval is granted, an implementation timetable should be established. A minimum of two years is required to fit the current budgeting cycle. All effected cost centers should be identified and their personnel thouroughly indoctrinated with the justification for the change and the detailed plans for implementation. The existing chart of accounts and management information reports should be revised accordingly.

More immediate is the requirement, both for justification of the policy change and actual implementation, for a detailed analysis of DLM costs. For each range instrumentation system, the relationship between the level of activity in operations and required DLM for that system, must be accurately established. This requires analysis of historical data and/or the use of engineering studies. The number of maintenance hours necessary for each direct hour of systems operation must be determined and the least squares technique should be employed to estimate the fixed and variable portions of the DLM services needed per time period.

The nest step is to set standard rates per system based on budgeted costs. Then, establish functional holding account job orders financed by industrial funds which would subsequently be relieved by a transfer of charges on a rate basis to the benefitting users.

APPENDIX A

RDT&E APPROPRIATION FORMAT

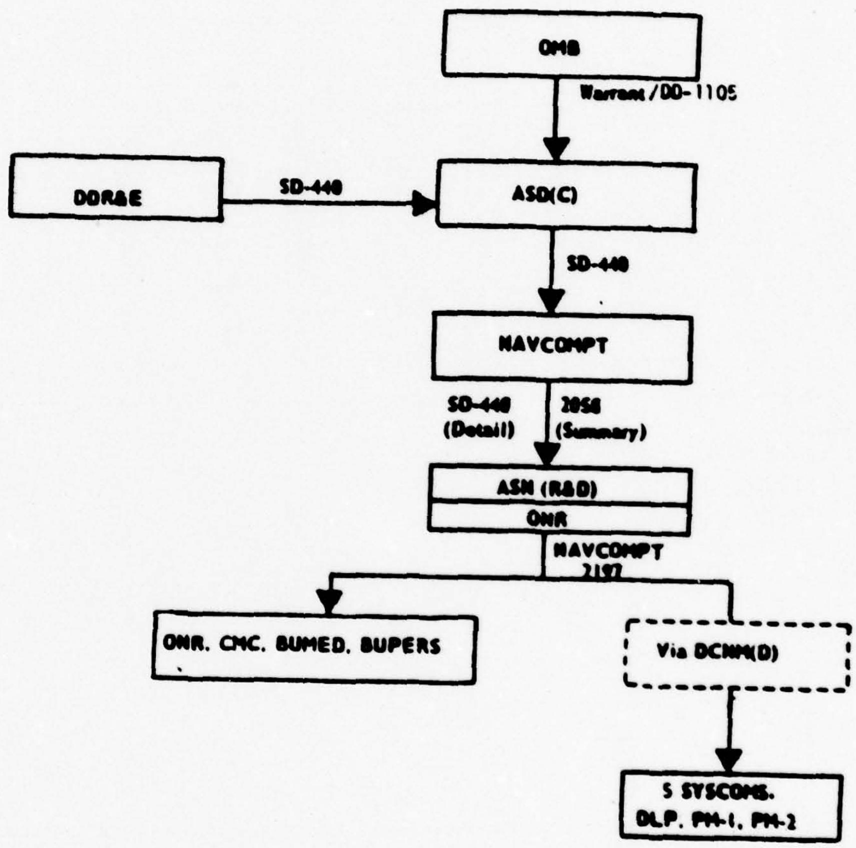
RDT&E ADMINISTERING ACTIVITIES

1. Office of Naval Research
2. Naval Medical Research and Development
3. NAVAIRSYSCOM
4. NAVSEASYSCOM
5. NAVELEXSYSCOM
6. Strategic Systems Project Office (SSPO)
7. Trident
8. Marine Corps RDT&E
9. NAVSUPSYSCOM
10. NAVFAC
11. Director Laboratory Programs
12. Bureau of Personnel

The administering activities are responsible for receiving budget requests from the field activities and consolidating these requests with the RDT&E work at their level. They also list funds according to category and submit this listing to ONR (6.1), CND (6.2), and Director RDT&E (6.3 and 6.4) for the budget request. They receive allocations (N/C 2197) from ONR and distribute funds on either 2189-1 or NC-140 to Navy activities. Industry expenditures are accomplished by contract negotiations, usually at the administering activity level.

FUND ALLOCATION FLOW, RDT&EN

18



Field Laboratory activities lie directly below the 12 Administering Office/Management Command levels in the above diagram.

A-2

THE SIX CATEGORIES OF RDT&E

6.1 Research (R). Research includes all effort directed toward increased knowledge of natural phenomenon and environment. This is the research-in-science phase.

6.2 Exploratory Development (XD). Exploratory Development includes all effort directed toward solution of specific military problems. This is the research-in-technology phase.

6.3 Advanced Development (AD). Advanced Development includes all projects which have moved into the development of hardware for experimental or operational test. This is the initial-application-of-new-technology phase.

6.4 Engineering Development (ED). Engineering Development includes those development programs being engineered for Service use, but which have not yet been approved for procurement or operation.

6.5 Management and Support (MS). This category includes efforts directed toward support of installation or operations required for general research and development use.

6.6 Operational Systems Development (SD). Operational Systems Development is identical to Engineering Development except that developments in this category have been approved for production and development.

A. DOD Programs

Program 0	Support of Other Nations
Program I	Strategic Forces
Program II	General Purpose Forces
Program III	Intelligence and Communications
Program IV	Airlift and Sealift
Program V	Guard and Reserve Forces
Program VI	Research and Development
Program VII	Central Supply and Maintenance
Program VIII	Training, Medical and Other General Personnel Activities
Program IX	Administration and Associated Activities

B. R&D Categories

Program VI, Research and Development, is subdivided into the following five categories:

Category 1	Research
Category 2	Exploratory Development
Category 3	Advanced Development
Category 4	Engineering Development
Category 5	Management and Support

For convenience in considering all programs funded from the RDT&E appropriation, a sixth category has been set up which includes all items in DOD Programs other than VI.

Category 6	Operational Systems Development

C. Program Elements

Some representative program elements funded from RDT&E follow:

Program VI Research and Development

R&D Category 1 - Research
61102N Defense Research Sciences

R&D Category 2 - Exploratory Development
62211N Aircraft

R&D Category 3 - Advanced Development
63308N Advanced Sea Based Deterent

R&D Category 4 - Engineering Development
64503N Sub Sonar Developments

R&D Category 5 - Management and Support
65801N Facilities and Installation Support

C0800

PROGRAM	CATEGORY	BUDGET ACTIVITY	ELEMENT	SERVICE
6	3	5	09	N

SERVICE

- A Army
- N Navy
- M Marine Corps
- F Air Force

ELEMENT

- 01 REACTOR PROPULSION PLANTS
- 06 ACOUSTIC COUNTERMEASURES
- 09 NEW SHIP DESIGN

BUDGET ACTIVITY

- 0 R&D SUPPORT FROM OTHER APPROPRIATIONS
- 1 RESEARCH (MILITARY SCIENCES)
- 2 AIRCRAFT AND RELATED EQUIPMENT
- 3 MISSILES AND RELATED EQUIPMENT
- 4 MILITARY ASTRONAUTICS AND RELATED EQUIPMENT
- 5 SHIPS, SMALL CRAFT AND RELATED EQUIPMENT
- 6 ORDNANCE, COMBAT VEHICLES AND RELATED EQUIPMENT
- 7 OTHER EQUIPMENT
- 8 MANAGEMENT AND SUPPORT

CATEGORY

- 1 RESEARCH
- 2 EXPLORATORY DEVELOPMENT
- 3 ADVANCED DEVELOPMENT
- 4 ENGINEERING DEVELOPMENT
- 5 MANAGEMENT AND SUPPORT
- 6 OPERATIONAL SYSTEMS DEVELOPMENT

PROGRAM

- 1 STRATEGIC FORCES
- 2 GENERAL PURPOSE FORCES
- 3 INTELLIGENCE AND COMMUNICATIONS
- 4 AIRLIFT AND SEALIFT
- 5 GUARD AND RESERVE FORCES
- 6 RESEARCH AND DEVELOPMENT
- 7 CENTRAL SUPPLY AND MAINTENANCE
- 8 TRAINING MEDICAL AND OTHER GENERAL PERSONNEL ACTIVITIES
- 9 ADMINISTRATION AND ASSOCIATED ACTIVITIES
- 0 SUPPORT OF OTHER NATIONS

APPENDIX B

DSARC/DCP PROCESS

ACQUISITION CYCLE

CONCEPTUAL PHASE:

Initial phase during which technical, economic, and military bases are established and the management approach is delineated.

Translates operational goals into technical goals.

PRINCIPLE OUTPUTS:

Refined statement of operational need.

Description of alternate approaches considered and decision rational.

Preliminary description of and performance specification for preferred system.

Risk analysis*, program plans and back-up information for above.

VALIDATION PHASE:

Preliminary designs and engineering (Engr) for system are verified or accomplished.

Management plans made.

Technical and economic bases for initiating engineering development verified.

Development prototypes built, tested, evaluated.

Development of attainable performance specification for system.

* Identify alternatives to satisfy the required operational capability (ROC) assess risks in cost, schedule and performance associated with each alternative, selection of preferred alternative via systematic means of evaluation.

Proposals for engineering development solicited and evaluated.

Full scale development contractor selected (DCP-DSARC II approval).

DECISION TO ENTER VALIDATION PHASE: based on:

System satisfies a military need, is worth cost and is affordable within overall fiscal constraints.

Mission and performance envelopes are adequately defined.

Major uncertainties identified and suitable method of resolution planned.

Preliminary cost and schedule estimates are realistic and acceptable.

Management approach and program planning are sound.

The Decision Coordinating Paper (DCP) - (formerly the Development Concept Paper)
Thresholds are well defined and provide the flexibility for accomplishing appropriate trade-offs in the validation phase while insuring the surfacing of significant problems.

FULL SCALE DEVELOPMENT

Completion of design and detailed engineering by contractor.

Low rate initial production (LRIP) prototypes built and tested to verify final design and produceability.

Beginning of massive commitment by Government; major adjustments to program will create substantial difficulties. ($ and time).

PRODUCTION

Production contract negotiated and awarded (DCP and DSARC III approval).

Quantity production initiated, greatest fund commitment.

Production acceptance tests (PAT) conducted to validate adequacy of the production model.

DOD commitment to program fully public; pattern of deep involvement and decreasing viable options for substantial system changes by government.

DECISION COORDINATING PAPER (DCP)

Content:

Nature of Program:
  Need/Threat

Program Description:
  Cost, Schedule, Performance risks
Alternative Programs
  Pros and Cons

Cost Effectiveness
  Trade-offs

Contract/Procurement Plan
  Achievement Milestones
  Acquisition Strategy
  Contract Plan
  Production

Management DOD Contractor
Reliability & Maintainability

Test & Evaluation
Logistics Support Plan

Environment Effects
International Aspects

Security Guidance
Thresholds

Recommendations by Signatories
Summary of Secretary of Defense
Decisions Over Program Life
Resource annex

A summary document to provide DOD management officials with essential information about a major system program. The DCP is periodically updated as the program advances through critical decision points in its life cycle.

Supports DSARC review and decision making process of the Secretary of Defense.

DEFENSE SYSTEMS ACQUISITION REVIEW COUNCIL (DSARC)

1. Review and recommendation body

2. Meets at request of service

3. DSARC I - Validation (Army, Navy Air Force)
   DSARC II - Full scale development (Army, Navy, Air Force)
   DSARC II A - Limited production (Navy/Air Force)
   DSARC III - Production and deployment (Navy/Air Force)

   For Army - DSARC III is limited production and DSARC III A is full production.

4. Limited attendance

Additional meetings if thresholds or characteristics set in Decision Coordinating Paper (DCP) cannot be met or appear doubtful in attainment.

DSARC ATTENDANCE

MEMBERS

DDR&E (Chairs DSARC I & II)

ASD (I&L) (Chairs IIA & III)

ASD (Comptroller)

Director, Defense Program Analysis & Evaluation

ASD (Intelligence) - as required

ASD (Tele-communications) - as required

SERVICE ATTENDEES

Secretary

Program Manager (Presenter)

Assistant Secretaries (as requested)

OTHER ATTENDEES

DDR&E (Test & Evaluation) - Presenter

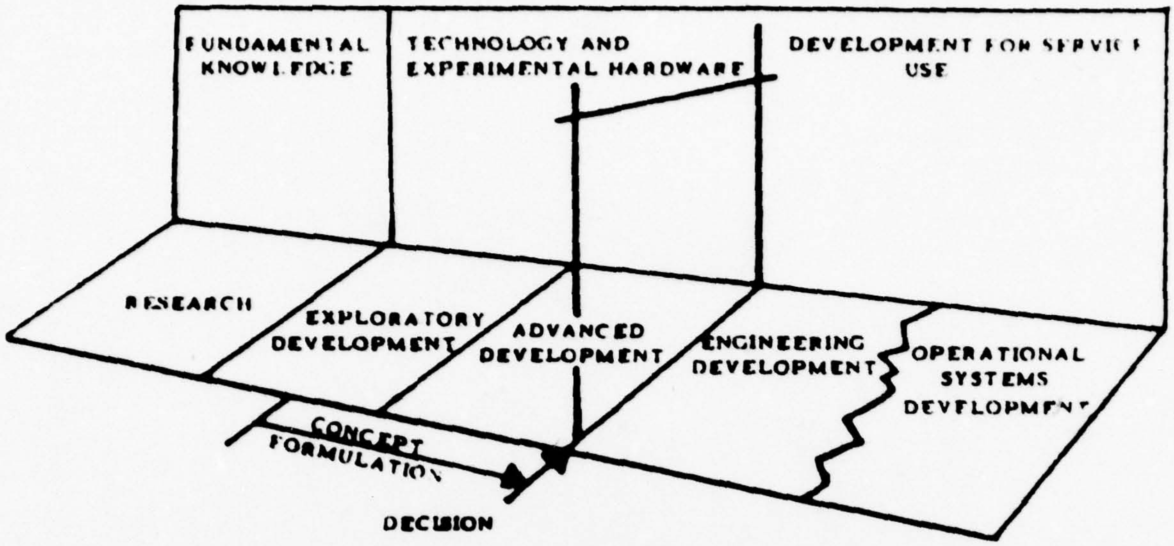
Cost Analysis Improvement Group (Craig) - Presenter

Deputy Secretary of Defense - As requested

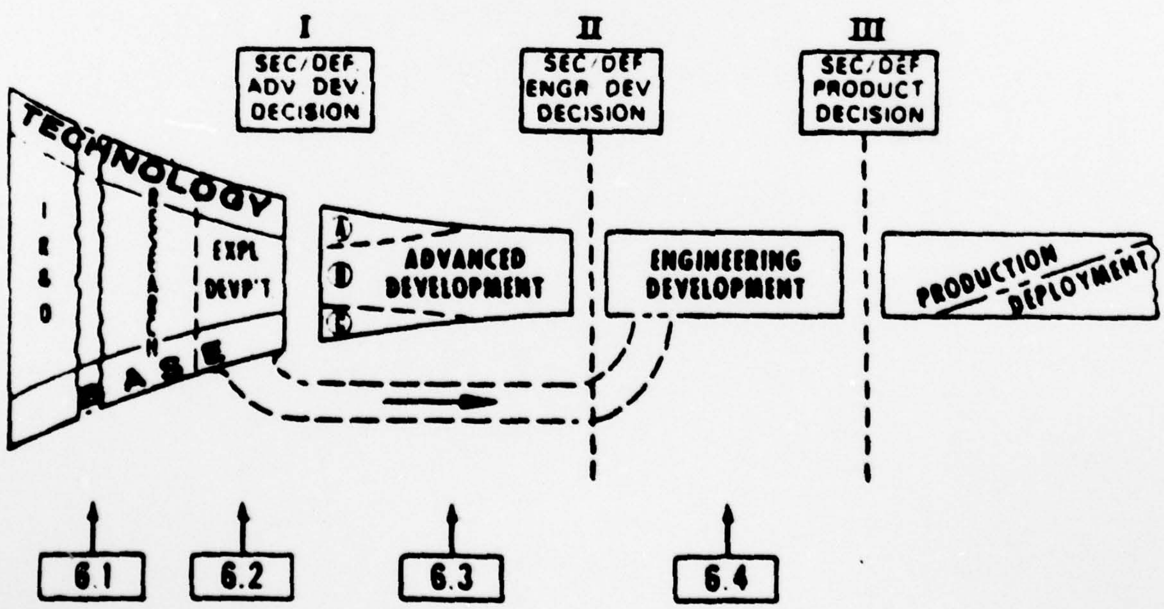
Members' Assistants - As requested

Chairman, Joint Chiefs Of Staff - As requested

RDT&E CYCLE



CLASSICAL PHASES IN DEFENSE SYSTEMS EVOLUTION



APPENDIX C - FINANCIAL MANAGEMENT

A. INTRODUCTION

Accounting, according to Webster's dictionary, is "A system of recording and summarizing business and financial transactions in books and analyzing, verifying, and reporting the results." Extending that conventional definition, accounting is an information system, expressed in monetary terms, which is utilized by individuals both from within and from outside an organization, in making decisions about that organization.

Commercial and Governmental institutions use similar accounting systems but there are two key differences in their application. The first deals with basic financial objectives. Commercial industries thrive on growth which involves the expansion of their capital base. Government, despite the contention of its critics, is not concerned with expanding its capital base but rather seeks to acquire resources and expend them in accordance with statutory requirements. The second involves control. Commercial enterprises have a built in control device in the profit motive. Government must use statutory, administrative, and budgetary rules to control its financial transactions. [Ref. 24, p. 11]

The fundamental purposes of federal government agency accounting are managerial control and accountability. The former requires the accounting system to provide information necessary for effectiveness and efficient management of its operations in terms of its allocated resources. The latter requires the system to enable management to report on the discharge of its responsibilities for those resources and operations for which it is held legally accountable. [Ref. 24, p. 81]

The structure of an internal accounting system used in a government agency should include planned input, planned output, the relation of actual output to the organizational objectives, and measure the organizational efficiency which is the ratio of actual outputs to actual inputs.

In this chapter, such a system is discussed. It is shown to be basic to the discipline of managerial accounting. Management's use of accounting systems in the planning and control functions will be highlighted. The process relating to accounting to individual behavior will be presented. Then, basic cost concepts will be defined for the subsequent examination of cost control, the central issue. The summary will relate the chapter discussion points to the thesis problem.

B. ACCOUNTING

Accounting is a multifaceted discipline that can serve a variety of needs as shown in figure 13. [Ref. 25, p. 162] Managerial accounting encompasses all of those aspects displayed and particularly those which are part of the control process. The management control function is employed to assure that resources are obtained and utilized effectively and efficiently in accomplishing organizational goals and objectives. Accounting is not the only source, or the most important, and its reports are not a substitute for "informal

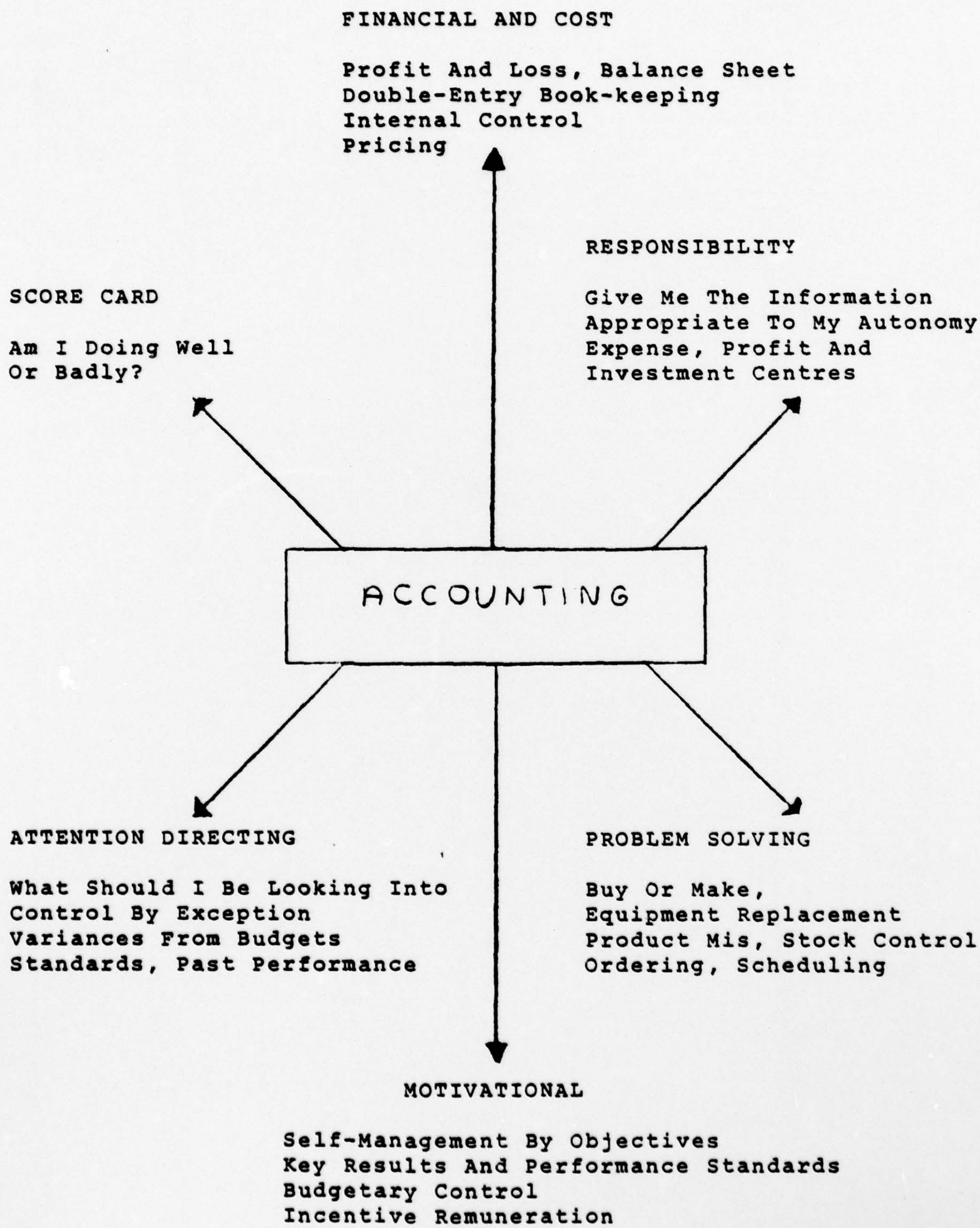

FINANCIAL AND COST
Profit And Loss, Balance Sheet
Double-Entry Book-keeping
Internal Control
Pricing
RESPONSIBILITY
Give Me The Information
Appropriate To My Autonomy
Expense, Profit And
Investment Centres
SCORE CARD
Am I Doing Well
Or Badly?
ACCOUNTING
ATTENTION DIRECTING
What Should I Be Looking Into
Control By Exception
Variances From Budgets
Standards, Past Performance
PROBLEM SOLVING
Buy Or Make,
Equipment Replacement
Product Mis, Stock Control
Ordering, Scheduling
MOTIVATIONAL
Self-Management By Objectives
Key Results And Performance Standards
Budgetary Control
Incentive Remuneration

FIGURE 13

person to person communication or for creation and maintenance of a good control atmosphere." [Ref. 26, p. 4]

Managerial accounting provides data for the internal use of managers vice the external users of financial accounting data. It is future oriented as those are the only costs that can be planned or controlled. There are as many managerial accounting systems as there are organizations using them and they are not, for the most part, governed by generally accepted accounting principles as are financial accounting systems. Its emphasis is on the managerial relevance of data and of particular interest in this thesis is its application in cost control.

Management cannot literally control the costs of making a product or providing a service, but it can and does control the actions of those individuals who incur those costs. The control is motivational and uses managerial accounting as an implementation process. The intention of this "motivational accounting" is manipulative. Information is deliberately selected and organized so that it induces the recipient to respond in a manner consistent with organizational objectives. It tries to insure that when the manager of an organizational segment who is responsible for expending resources acts in his own best interest, he also acts in the best interest of the organization as a whole.

This process is one of the tenets of Management by Objectives, MBO. Its aim is to integrate the company's objectives with the personal goals and satisfaction of its employees. It provides for the maintenance and orderly growth of the organization by means of statements of responsibility of everyone involved, and measurement of achievement.

Concomittantly, it helps overcome some chronic problems of managing managers and professionals. It provides a means for measuring their true contribution, clearly defines major areas of responsibility, is a means for determining a managers span of control, is an aide in salary determination by paying for results vice efforts and identifies potential for advancement. /Ref. 27, p. 10/

MBO enables each manager to establish a mechanism for self control through the definition of key results and performance standards that he must personally achieve in line with organizational objectives. Allied to this is the determination of priorities for improvement, broken down in specific responsibilities for each manager during a given period.

Accounting information fills two needs in this process. First, it acts as a scorecard in accumulating information for measuring performance. Secondly, it directs attention to deficiencies in performance.

If NBO is not used, this same information is basic to another control process called Management by Exception, MBE. In its simplest form, it is a system of identification and communication that signals the manager when his attention is needed and remains silent when it is not required. No accounting system could make a perfect distinction between those two situations, but careful design of a system can come close enough to be a useful management tool.

The key elements of the system are measurement standards, projection measures that ensure meeting organizational objectives, criteria to measure progress made toward those objectives, comparing actual with planned performance and identifying exceptions, then taking action to bring performance back to standards or adjusting the measure to changed conditions. /Ref. 28, p. 15/ The system is totally dependent on a managerial accounting system for data and control.

Management information needs for the planning and control function are most often in a cost format. Costs are defined as a sacrifice made such as expended cash, transferred property, or services performed in order to obtain desired goods and services. The definition is accepted and used extensively in financial accounting. In managerial accounting, the term cost has a much broader meaning that calssifies various costs in a manner which fulfills the different information needs of management. /Ref. 29, p. 24/

C. COST CONCEPTS

Costs are used by the manager to organize and classify data. The kinds of costs incurred, and the manner in which they are classified depend on the type of organization. PMTC provides a service and does not have manufacturing or merchandising costs, therefore, they will not be considered.

Direct costs are those that are directly traceable to an object, activity, organizational segment, or responsible individual. Indirect or common costs are not so traceable, such as indirect labor and administrative overhead. Period costs are a type of common costs which are identified with a particular time interval. Rent is an example as is annual level of minimum maintenance. Period costs include all fixed overhead costs.

A more distinct difference between direct and indirect costs is their relevance to decision making. Minimum maintenance costs would be considered a direct cost to a general manager because his decisions could effect those costs. An operations department head would consider them as indirect because he could not effect them with his decision authority.

Costs are further classified as to their behavior, specifically their response to changes in the level of production or service activity. Fixed costs, such as rent, do not change with the level of activity. Variable costs, such as direct labor, do change. Supervisory costs can be an example of a mixture of both fixed and variable and are classified as semifixed.

Cost behavior is multi-determinant. A management decission to freeze hiring and prohibit overtime makes the usual variable labor cost a fixed cost. The longer the time span of consideration, the more fixed costs become variable costs; and in the long run, all costs are variable. From an organizational perspective, heating costs may be fixed to an operating department head but variable to the generating department head.

Variable costs are usually affected by decisions made by operational management and fixed costs are usually affected by the strategic planning decisions made by top management.

Direct costing is an accounting method that charges all fixed and variable costs that can be traced to a product or service. It excludes period costs that "arise from provision of capacity for production and keeping capacity in readiness regardless of the extent to which it is utilized." /Ref. 30. p. 6/ Within relevant ranges of activity, period costs do not vary, whereas, direct costs are incurred if goods or services are produced and not incurred if they are not produced.

Conversely, absorption costing is an accounting method that charges all costs, including period costs, to the product or service. Unlike direct costing, it does not require traceability to the end product. Thus, this method's advocates contend that the fixed and variable behavior aspects of overhead costs are immaterial as far as product or service pricing is concerned. A key difference between absorption and direct costing is how the two costing methods are controlled by management.

D COST CONTROL

The steps in the management control process are shown as a flow diagram in figure 14 /Ref. 29, p. 10/ and are shown to revolve around two separate but related activities, planning and control. Planning is concerned with what and how, and control is concerned with attaining the desired results. They are complimentary to each other and one without the other is meaningless.

The essence of managerial control is knowing what is happening and knowing soon enough to take corrective action,

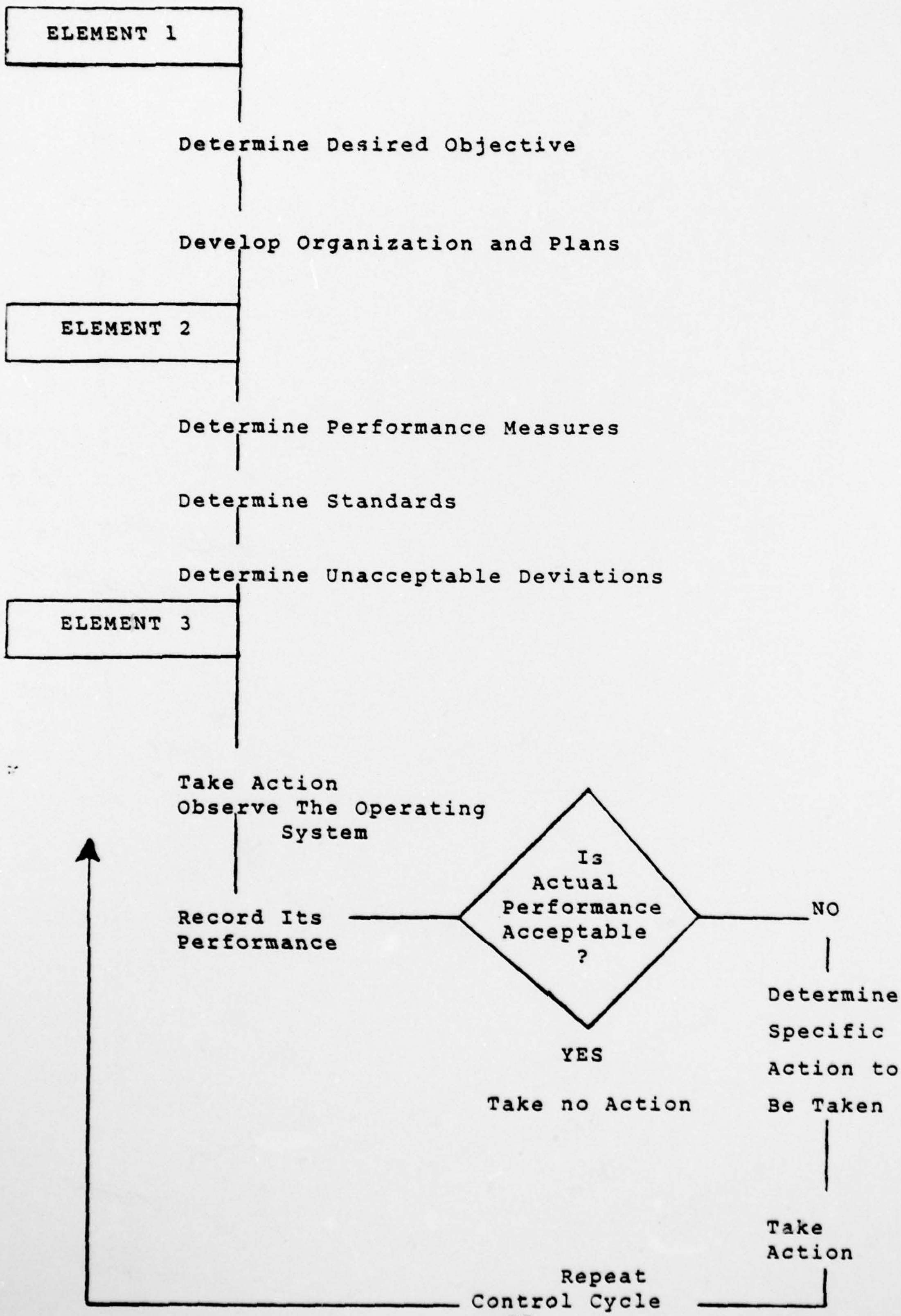

ELEMENT 1
Determine Desired Objective
Develop Organization and Plans
ELEMENT 2
Determine Performance Measures
Determine Standards
Determine Unacceptable Deviations
ELEMENT 3
Take Action
Observe The Operating System
Record Its Performance
Is Actual Performance Acceptable ?
NO
YES
Take no Action
Determine Specific Action to Be Taken
Take Action
Repeat Control Cycle

FIGURE 14

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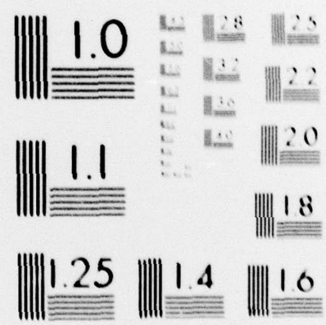

MICROCOPY RESOLUTION TEST CHART
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if necessary. Effective cost control is dependent on information and action with management itself being the process of converting information to action.

Individuals making decisions cause costs. Controllable costs are those that can be directly regulated by a given individual within a given time period. Costs are controlled by management actions which are directed at those sources from which the costs originate.

Control of direct costs requires setting standards for various levels of activity and then comparing actual and planned performance using variance analysis techniques that will be discussed later in the chapter. Period costs are independent of short fluctuations in activity and are controlled by budgeting for a specified amount of dollars per budget cycle. Management simply limits the expense of input resources to the budget quantities regardless of activity levels.

The size and complexity of modern organizations requires decentralization of decision making. Delegation of that authority is a prime reason for internal accounting. The entire system of statements, reports and analyses, schedules, and budgets is largely designed to let top management delegate yet maintain control.

Responsibility accounting is a "system of accounting that relates each cost and revenue item both to the individual who makes decisions affecting that item and the physical object or activity that causes the expense or revenue to occur." [Ref. 31, p. 41] It collects and reports planned and actual accounting information in terms of responsibility centers, that is, the individual responsible for incurring the cost. This requires direct cost information.

The control system provides ways to separate cost items that are controllable by a responsibility center from those that are not by whether the center's supervisor can influence costs by his decisions. Direct labor and material costs are usually controllable and overhead costs such as indirect labor and general administration are usually controllable in part. Allocated costs, by definition, are not controllable. [Ref. 32, p. 36] They are determined in accordance with an allocation formula and not by the actions of a responsibility center supervisor.

A further classification of controllable costs is expressed as engineered and management costs. Engineered costs are elements of costs which can be estimated for specific jobs, if it is known how much direct labor is required to make a widget, and the prevailing wage rate, then the total direct labor cost can be estimated. Management costs are discretionary, they are what management wants them to be. There is no methodology for calculating the "right" amount. Training and safety costs usually fit in this category as do maintenance costs that are incurred for a management derived functional requirement. Depot level maintenance uses a combination of engineered and management costs for planning and control purposes.

Reduction of engineered cost is almost anways beneficial to the organization. Reduction of management cost is more difficult to readily appraise. Foregoing planned maintenance may be such a reduction that could be quite costly to the organization in the long run. Engineered costs are usually a function of activity, management costs are not.

Allocation of service department costs, such as maintenance, are generally not useful for cost control. If such costs were allocated, the responsibility center charged would have no control over the costs. There would be an inherent conflict with the operating department contending that the changes were to high due to maintenance department inefficiency, and the maintenance department countering that poor operating practices caused increased maintenance requirements.

It is possible to change non-controllable costs to controllalbe costs. If maintenance department costs were charged to production responsibility centers as part of an overhead rate, they are non-controllable; if maintenance charged the operating department a standard amount per maintenance function, regardless of actual labor or material expended, and the operational department was responsible for the quantity of maintnenace requested, then both supervisors control the costs.

Another method of effecting the nature of control is by charging the locus of responsibility for decision making since all costs are controllable at some level. Centralizing decision making responsibility removes it from the operating environment and it becomes less responsive to existing dynamic conditions.

E. BUDGETING AND COST ANALYSIS

A budget is a plan expressed in quantitative terms. It is built up by responsibility centers and in the absence of engineered costs, the amount budgeted is a judgment call. This judgment is made, in accordance with the motivational concepts discussed earlier, as a joint agreement between a supervisor and his superior. Most of the budgeting process involves establishing the permissable level of management costs.

Its aim is not just to limit expenditures. It has more useful and constructive goals, i.e., "the budgetary process is a means for obtaining the most productive and profitable use of the company's resources via planning and control." [Ref. 33, p. 122]

As discussed in the previous chapter, flexible budgets are a series of alternate budget plans for different levels of expected activity. By comparing actual results achieved for a realized level of activity, with the budgeted performance for that same level of activity, it is possible to measure efficiency in a meaningful way.

There are some common pitfalls in budgeting. Estimates are based on assumed conditions and relationships. Allowances for performance are a factor of volume, rather than time, and comparisons and evaluations of current information are made using historical data.

Analysis of all accounting data involves comparisons. The judgments made about current performance are not derived by using abstract or absolute criteria but rather by comparing current performance data with other data. Comparative differences are called variances. It is of little use to just know that there is a variance, but the factors that cause the variance could be all important.

Variances can be the result of inaccurate standards or a change in conditions which effects performance projections. If the purchase price of maintenance materials goes up, the result is an unfavorable material variance. It does not infer excessive cost or unfavorable purchasing performance. It means the standard is no longer appropriate. If a reduction-in-force caused the average wage rate of maintenance workers to increase, it would result in an unfavorable direct labor variance. The changed condition has made the performance standard inaccurate, in terms of dollars. However, the total hours of performance remains unchanged. The point is that variance analysis must be directed to uncover the causative elements.

F. SUMMARY

Accounting systems are used by management to assist in obtaining effectiveness and efficiency goals in operations. Managerial accounting is a flexible, behavior-oriented tool that provides the information needed to plan and control operations. It is the communication medium of motivational management processes.

Maintenance is accomplished by incurring both direct and period costs. At PMTC, direct maintenance costs could be considered any part of operator, intermediate, or DLM charges that

that were incurred because of actual instrumentation use. Period costs are those that are required to maintain a minimum level of T&E capability, independent of the number of T&E operations.

When absorption costing is applied to the maintenance function through the operating department or the service user, all costs would be recovered. If a direct costing system is used, only direct maintenance costs would be recovered.

If the maintenance director is designated as the responsible individual for planning and controlling maintenance costs, then he must also be given the commensurate authority that make those costs controllable.

Maintenance costs are a combination of engineered and management costs. As more historical performance data and procedural manual information becomes available, engineered costs increase and management costs decrease.

The primary tools of management planning and control are budgeting and variance analysis. Both are dependent upon responsibility accounting and cost control. Again, for maintenance management to effectively use the tools, it must control costs.

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