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DEPOT MAINTENANCE MODERNIZATION

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David Glass
Lawrence Schwartz

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LOGISTICS MANAGEMENT INSTITUTE
6400 Goldsboro Road
Bethesda, Maryland 20817-5886

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Maintenance depots perform overhaul, repair, and modification of military systems. The facilities may be contractor-owned or -operated as well as DoD-owned and -operated. However, the DoD maintenance depots are needed to meet sudden increases or surges in maintenance demands that may arise from increasing tensions or from mobilizing for wartime. Consequently, the Military Services have been spending more than $\frac{1}{2}$ billion per year on modernizing their equipment and buildings in the depots.

This report evaluates the decision process for modernizing the DoD maintenance depots. The key questions addressed are:

- Strategically, does DoD modernization satisfy the depot-maintenance requirements that would arise from increased tensions or from mobilization?
- Technologically, are the capital investments in the depots made according to any of the new, dynamic repair processes – e.g., Group Technology and flexible repairs?
- Operationally, are capital investments proposed, approved, and financed to support modernization strategies?

Certain recommendations are made to improve the decision-making process for modernizing the depots. Keywords:)

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Executive Summary

DEPOT MAINTENANCE MODERNIZATION

The Military Services spend over $500 million annually modernizing maintenance depot facilities and equipment. Those capital investments, by and large, are made piecemeal, primarily to enhance peacetime operating efficiency or capability. They are biased toward projects that provide quick payback. Pressure to obligate funds quickly exacerbates the tendency to undertake small, easily justified, short-term projects. By using this piecemeal approach, the Military Services are missing the benefits of an integrated series of investments following a planned, technological direction. Most importantly, they are risking their depots' abilities to accomplish essential wartime missions.

We recommend that the Assistant Secretary of Defense (Production and Logistics):

- Reaffirm DoD policy that the primary mission of the Military Services' depot maintenance activities is to support the forces in times of increasing tension and mobilization and prescribe that capital investments be focused on enhancing that capability.
- Task the Military Services to develop modernization strategies for their maintenance depots, derived from their primary missions and planned technological directions.
- Issue a Policy Memorandum prescribing that internal rate of return be used by the Military Services when assessing the economic merits of capital investments.

These actions can lead the way toward eliminating many of the shortcomings in DoD's depot maintenance modernization programs. Reaffirmation of policy will clarify the roles and missions of organic maintenance depots; modernization strategies will give impetus to the capital-investment programs of the Military Services; and the Policy Memorandum will assure that the capital investment projects comprising those programs provide the greatest return.

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CHAPTER 1

INTRODUCTION

GENERAL

The ability of the DoD to keep U.S. forces in a high state of readiness in peacetime and to support them in wartime rests largely on the capability of its depot-maintenance structure.

This structure includes contractor-owned or -operated facilities and DoD-owned and -operated facilities. The DoD facilities – hereafter referred to simply as depots – are expected to bear the brunt of any additional workload in times of increasing tension or war. The major depots include within CONUS: eight Army depots, eight Navy shipyards, six Naval Aviation Depots, five Air Force Air Logistics Centers and two specialized activities, as well as two Marine Corps Logistics Bases. (Those depots, as well as other facilities not of immediate concern to this study, are listed in Appendix A.)

The depots are large, highly capable industrial activities. They operate extensive facilities and equipment to perform overhaul, repair, and modification of military systems. Often, they are among the largest employers in the states in which they are located; they are, therefore, of major political interest.

The capital investment in these facilities is massive: a current value conservatively estimated at $17 billion and annual investments of $1½ billion in each of the past few years. One of DoD's continuing challenges is to assure that these annual investments in depot modernization are made wisely.

How these investments are made and our recommendations for improvement are the subjects of this report.

CURRENT ENVIRONMENT

The current environment for depot maintenance in the DoD is characterized by increasing complexity in the supported weapon systems, concurrently increasing

sophistication of repair techniques, increased concern over environmental issues, and by a steady or declining overall DoD budget.

Accompanying these general trends are several Military Service-specific trends. The Navy is increasing its emphasis on competition between organic and contractor depots. The Navy also has a general shortage of military construction (MILCON) funds, partly because of the homeporting initiative which requires much new construction. The Army is planning to decrease the number of civilian personnel positions at its depots – causing greater reliance on contractors. Moreover, the demands of the two new Army divisions are creating a shortage of MILCON funds for the depots and draining military and civilian personnel from the depots. Finally, the Air Force has recently placed an increased emphasis on improving its overseas depot structure, which may have important implications for the Air Force's depot modernization program.

The depots are also facing a technological revolution. The characteristics of the items being repaired are undergoing substantial change. For example, the use of composite materials is becoming commonplace in weapon systems, thus necessitating the establishment of composite-repair capabilities at many of the depots. Furthermore, the increased application and complexity of electronics in many Defense systems has increased the need for large, specialized test stations for diagnosing faults. Yet, at the same time, the workloads at those test stations have decreased because the electronic components have become more reliable. Finally, software is becoming an important component of the maintenance workload.

A second trend in technology stems from the changing characteristics of the industrial processes employed in repair and overhaul. These include increased use of computer-controlled machine tools, robotic paint spraying, and plastic-media blasting for paint removal. Lasers are also used in a wider variety of processes, such as paint removal and detection of inadequate bonding.

Moreover, strides are also being made in organizing and using the industrial facilities. The depots are beginning to apply the concepts of Group Technology, cellular manufacturing, and total quality management. These and other innovative process improvements, which are described later in this report, may change the nature and direction of future capital investments.

ORGANIZATION OF THIS REPORT

This report discusses the Military Services' modernization strategies and their processes for making capital investments.

Chapter 2 presents our conclusions and recommendations regarding the issues associated with modernizing DoD's maintenance depots. The findings that support these conclusions and recommendations, along with descriptions of the capital-investment processes, are presented in Chapters 3, 4, 5, and 6 – one for each of the Military Services. The technical issue of the economic analyses used to evaluate capital investments is discussed in Chapter 7.

CHAPTER 2

CONCLUSIONS AND RECOMMENDATIONS

MODERNIZATION STRATEGY

A modernization strategy for depot maintenance provides a context for making decisions on capital-investment projects, including building or renovating facilities, or buying, installing, or rebuilding equipment. Without such a context, capital-investment decisions tend to be made on an ad hoc, project-by-project basis.

In this section we concentrate on two issues that are crucial for "good" modernization strategies in the Military Services: (1) To what extent do the strategies effectively provide for accomplishing the mobilization workload? (2) Do the strategies give a clear picture of what the depots should look like in the future and what technologies they should use?

Mobilization

We believe that the issue of mobilization must be at the heart of any modernization strategy. The primary reason for having DoD maintenance depots is to meet the surge (sudden increase) in workload during periods of rising tension and mobilization. Indeed, if the depots do not have an important role in preparing and supporting our forces until the private sector becomes fully mobilized, then much of DoD's depot maintenance should be done on contract.

The issue of mobilization is central to the depot system. It is also an extremely complex and difficult problem that has many facets. The most obvious is: In the event of mobilization, how much depot-maintenance work is expected and when? The estimates of mobilization workload depend on many assumptions: the wartime scenario envisioned, the demands for items resulting from usage and losses in the wartime scenario, the amount of manufacturing and modifications that the depots will need to do, the source of repair in wartime, and the ability to retrograde items to the CONUS depots in wartime.

The role of field teams is another issue that needs to be considered. Many depots routinely provide teams of depot workers to perform repairs in the field requiring their particular expertise. Use of field teams will probably increase substantially in wartime to repair equipment damaged in battle or simply to do repairs closer to the front. Assumptions about the use of field teams in wartime dictate not only the wartime labor available at the depots, but also the training and equipment needed in peacetime to prepare these workers for their wartime role.

Capital-Investment Criteria

The kind as well as the volume of work that may be needed in wartime will likely differ from that in peacetime. (One example is battle-damaged components.) Consequently, different facilities and equipment may be required in wartime to accomplish mobilization workloads than those that are needed in peacetime. Those differences need to be incorporated into the requirements for new facilities and equipment. However, we have found that this is not the case.

> ***Conclusion.*** Capital-investment decisions are rarely made on the basis of mobilization requirements.

Capital investments are almost always justified on the basis of accomplishing peacetime workloads. Although the existence of the depots is based on their wartime function, the depots are judged on peacetime efficiency and output, not on retention of wartime capability. In capital-investment decisions, mobilization is an afterthought. The primary criterion is: Will the investment help complete peacetime work responsively and at a reasonable cost?

One frequently cited justification for this strong peacetime orientation is that, given the right mix of peacetime workload and a single-shift peacetime operation, the resources on hand would be sufficient to accomplish the wartime workload using multiple shifts. However, it is difficult to determine the "right" mix of peacetime workload, particularly when the wartime workload is so uncertain. Moreover, in most cases, the only resource that has been identified to meet the wartime workload is direct labor hours; seldom is a calculation made of the equipment and facilities needed in wartime.

In fact, the Air Force and the Navy use two very different approaches to define the right mix of peacetime workload. The Air Force attempts to have a mix of high- and low-surge workload in peacetime, so that upon mobilization the low-surge

workload (i.e., airframes) can be completed in the first 30 days – thus freeing the workers to move to the high-surge workload (i.e., engines and components) as the war progresses. In contrast, the Navy seeks to maximize, during peacetime, the amount of high-surge workload in its aviation depots so as to minimize the changes necessary to meet its wartime workload. The Navy's rationale is that by planning its workload in this manner it will then have workers trained in the right skills and have the right equipment on hand. However, it is our understanding that the Navy Aviation Systems Command (NAVAIR) is now moving towards the Air Force's approach to balancing high- and low-surge workloads.

> ***Conclusion.*** If organic depots are to be used as the primary source of repair capability during periods of increasing tension and mobilization, then the correct balance between the high- and low-surge items in peacetime workloads needs to be determined.

In the Navy, the tendency to base capital-investment decisions on peacetime workload is being reinforced by the emphasis being placed on competition for peacetime workload. In Naval Aviation Depots, for example, much of the workload is now considered at risk to competition from the private sector. As a result, any investment that does not make the depot more competitive will not be made – including any increase in capacity needed for mobilization that does not pay for itself in peacetime. In fact, the depots have been encouraged to make strategic capital investments that establish new capabilities to compete for new work in peacetime, not to help accomplish the workload in wartime.

> ***Recommendation.*** To tie the modernization of the depots to the mobilization requirements, the Assistant Secretary of Defense (Production and Logistics), ASD(P&L), should reaffirm DoD policy that the primary mission of the Military Services' depot maintenance activities is to support the forces in times of increasing tension and mobilization, and prescribe that capital investments be focused on enhancing that capability.

Technological Direction

Establishing a technological direction for the depots is the second essential element of an effective depot-modernization strategy. A technological direction provides a context for the many individual modernization projects that are proposed to solve specific operational problems at depots. Without such a direction, projects

tend to be evaluated without considering their interactions with one another, tend to simply replace old equipment with new equipment of the same type, and tend to ignore large-scale, multiyear efforts that are typically a part of effective technological strategies.

The Military Services have started several efforts for providing this direction and there are some examples of new technological approaches being used in individual depots. However, based on our review of capital-investment decisions and the methods used to make these decisions, we make the following conclusion:

> ***Conclusion.*** The depots do not have a technological direction for modernization and, therefore, their capital-investment decisions are made on a case-by-case basis. As a result, opportunities for major improvements may be missed.

As an example of a technological direction, technology could be introduced into the depots by: first, simplifying the current repair process by using Group Technology and by organizing the shop floor into repair cells; second, controlling production and inventory with computer-based technologies [e.g, Manufacturing Resources Planning Systems (MRP II) or Optimized Production Technology (OPT)] as needed; and third, introducing automated repairing as appropriate [e.g., Flexible Manufacturing Systems, Computer Integrated Manufacturing (CIM), robotics].

The general argument for this particular technological direction is strongly made in the literature. Group-Technology repair cells simplify the repair processes. Those simplified repair processes set the stage for the successful implementation of computerized production and inventory controls. After operating with this simplified and controlled repair process, any automation that might be needed will become evident and can be successfully justified and introduced. (See page 5-2 for an example of Group Technology.)

Such a technological direction provides a broad outline for the kinds of capital investments that should be made at various stages of modernization, and it also provides a context for the particular capital investments that would be beneficial for a particular maintenance depot. Of course, this and any other technological direction should be validated against not only the criterion of efficiency, but also the criterion of mobilization requirements.

Recommendation. ASD(P&L) should devote the 1988/89 DoD Depot Maintenance Seminar to helping the Military Services define technological directions for their depots.

The Depot Maintenance Seminar presents an excellent opportunity for addressing the technology issue. With strong leadership from the Office of the Secretary of Defense (OSD), possible technological directions could be formulated beforehand and discussed at the seminar. It would also serve as a forum for communicating the best technological approaches being used by the Military Services. This could lead to the establishment of centers of expertise to test the most promising of those technological approaches.

Summary

Integrating these two elements, mobilization and technological direction, into a unified strategy for depot modernization is the next step. This step must be undertaken by the individual Military Service to take into account their differing missions and requirements.

Recommendation. ASD(P&L) should task the Military Services to develop modernization strategies for their maintenance depots, derived from their primary missions and planned technological directions.

The strategies should explicitly state: how and where the Military Service plans to accomplish mobilization missions, including the use of field teams and forward depots; a method for reflecting the mobilization needs in the peacetime posture of the depots; a planned technological direction; and an outline of a capital-investment program to carry it out.

A coherent modernization strategy will go far to improving the modernization of the DoD maintenance depots.

CAPITAL-INVESTMENT PROCESS

The process by which capital investments are made -- developing proposals, establishing priorities, obtaining approval, and committing the funds -- can either help or hinder any modernization strategy. Based on our review of the Military Services' capital-investment processes, we conclude the following:

Conclusion. The capital-investment process for DoD's maintenance depots is biased against large-scale, long-range,

integrated projects, which makes it difficult to carry out an effective modernization strategy.

This bias arises from four major causes. First, most of the modernization projects are proposed by different divisions within the depot in reaction to problems they encounter. The depots and commands then rank and approve these projects on their individual merits. This bottom-up process suggests that a depot-wide or command-wide commitment to modernization is difficult to obtain and sustain.

Second, if a project requires MILCON, Asset Capitalization Program (ACP), and technology funding, there is a high probability that one of these funding sources will not be available at the right time in the right amount. This is further compounded by the three separate justification and approval procedures that are required.

Third, the Military Services, and consequently the depots, are under considerable pressure to obligate authorized funds as quickly as possible. In the case of purchases of equipment under the ACP, the pressure to obligate funds quickly – a practice that goes counter to the intention of ACP – makes it difficult to embark on technologically complex projects, which usually have long lead-times.

> ***Recommendation.*** ASD(P&L), in conjunction with the ASD (Comptroller), should develop an alternative to using obligation rates to judge the effectiveness of a depot's ACP.

The ACP monies made available for the purchase of equipment do not expire, yet these funds have been removed from some depots and reallocated to other depots in midyear on the basis of obligation-rate performance. The use of this obligation-rate criterion encourages quick investment decisions and has resulted in uneconomic ACP investments in the depots.

Fourth, the near unavailability of MILCON funds for large construction projects, coupled with the low dollar-value ceiling on individual minor-construction projects, forces depots to build groups of very small facilities. As a result, larger facilities that are better economic investments – and part of a strategy – may not be built.

> ***Recommendation.*** ASD(P&L) should examine the feasibility of either raising the dollar ceiling on individual projects for minor construction or of capitalizing facilities.

The existing $200,000 ceiling on individual minor-construction projects – coupled with the dearth of MILCON funds – has also led to uneconomic investments in the depots.

Economic Analysis

Another key factor in the capital-investment process for maintenance depots is the economic analysis used in evaluating capital investments. Different aspects of a strategy are assessed by various economic methodologies, and these approaches are inconsistent with one another. Within a particular Military Service, for example, the criterion of payback may be applied in evaluating the purchase of equipment and present-value may be used to evaluate the construction of a building housing that equipment. As a result, the economic worth of different aspects of a strategy may be misjudged and mismatched.

In addition, the economic methodologies now in use tend to be biased against high-technology investments, whose benefits often accrue over the long term. For example, a payback of 4 years or less has been used to judge the economic worth of high-technology equipment as a replacement for older, worn-out equipment. Though the benefits of that equipment usually continue for many years, the payback criterion gives no consideration to benefits that accrue after the first 4 years. Consequently, the short-run orientation of the economic analyses that are used to evaluate capital investments in the depots tend to bias decisions against some high-technology investments that could be necessary for a coherent modernization strategy.

To overcome the difficulties created by the use of these economic analyses, we make the following recommendation:

> ***Recommendation.*** ASD(P&L) should issue a Policy Memorandum prescribing that the criterion of the internal rate of return be the single methodology used by the Military Services when comparing the economic merits of capital investments in maintenance depots.

To aid in the implementation of this recommendation, we have prepared a draft Policy Memorandum establishing a uniform economic analysis for capital investments in the maintenance depots. That draft Policy Memorandum is provided in

Appendix D. The ASD(P&L) should also assist the Military Services, as needed, in preparing handbooks and standard software to implement the Policy Memorandum.

The internal rate of return equates measurable benefits and costs of each capital investment to determine its rate of return. These rates of return are then used to rank projects. By extension, the internal rate of return also lends itself to the evaluation of difficult-to-measure benefits, such as shorter throughput times and meeting safety and health standards.

SUMMARY

Implementation of the recommendations in this chapter, combined with the ongoing efforts of the Military Services, will help improve the modernization of the maintenance depots. Establishing a modernization strategy based on the role of the depots in periods of increasing tension and mobilization and on a clear technological direction will provide the context for making good capital-investment decisions. Working on eliminating the pressure for high ACP obligation rates, addressing the question of facilities funding, and using internal rate of return for economic analyses will remove some of the impediments in the capital-investment decision-making process.

The following chapters describe the current capital-investment processes in the Military Services and highlight some of the findings that led to our conclusions and recommendations.

CHAPTER 3

ARMY

MODERNIZATION STRATEGY

Mobilization Workload and Posturing

In January 1987, the U.S. Army Depot Systems Command (DESCOM) reviewed its entire modernization program and initiated development of a new strategy: "Ready-2000." As part of that review, the issue of the mobilization-manufacturing base emerged, particularly the need for the U.S. Army Materiel Command (AMC) and DESCOM to better define and support the requirements for workload during mobilization.[1]

Mobilization workload is addressed in the Army's *Depot Maintenance Posture Planning for Mobilization*. That document, however, is primarily concerned with labor. For example, it details plans for using reservists at the depots during mobilization. The reservists who train at the Army depots in peacetime would work for the first 30 days of mobilization at those activities, thereby serving two purposes. First, the reservists would receive intensified training at the depots before performing maintenance duties overseas. Second, with the reservists working at the depots during this period, the activities could then concentrate on hiring and training civilian personnel for their longer run needs.

The Army's posture plan does not address equipment and facilities in any detail. Such basic questions as what items will surge are not addressed. This makes capital-equipment planning very difficult.

At Tobyhanna Army Depot, for example, approximately 60 percent of the workload in peacetime is in fabrication. If, on the one hand, fabrication work is expected to surge during mobilization, manufacturing equipment and related assets should be modernized. Alternatively, if Tobyhanna's repair work is expected to

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[1]See DESCOM. *Revitalization of Army Depots for the Year 2000, Strategic Plan*. Draft, Apr 1987.

increase during mobilization, then the modernization of capital equipment should go in a different direction.

> ***Findings:*** The Army's mobilization requirements for depot maintenance equipment and facilities are not well defined and, therefore, capital-investment decisions are not being made on that basis.

Technology

The Ready-2000 initiative also included an outside review of the technology in the Army's maintenance depots. As part of that review, Dr. Dan Shunk, Assistant Professor of Industrial Engineering at Arizona State University, concluded that the depots need an overall technological strategy. Specifically, he recommended that a variety of technologies be examined, including:

- Computer-aided design/manufacturing/engineering
- Flexible manufacturing system
- Computer numeric control, digital numeric control, and numeric control
- Combining materials or work involving like processes into a single line (Group Technology).

He urged that DESCOM and the depots work together to define the Army's depot-of-the-future. Once the concept of the depot-of-the-future is specified, it will serve as a guideline for the depots' purchases of equipment and facilities.

The conclusions of Dr. Shunk are supported by our field observations. At Anniston Army Depot, equipment and facilities are being purchased without a strategy for technology. Although Anniston is using computer numeric control machines, they are not being linked together to take advantage of increased productivity and information-sharing gains. Moreover, the selection of the machines and processes to be located in the new machine shop that is under construction is not being guided by any clear strategy for evolution to a new process technology, such as a flexible manufacturing system or Group Technology.

Similarly, at Tobyhanna Army Depot, capital investments are being made which may not fit into a concept of the depot-of-the-future. Tobyhanna has just installed a large, centralized Automated Storage and Retrieval System. However, other depots are finding that several small distributed automated storage and

retrieval systems can be much more productive. The decision to build a centralized system may have been correct; however, this cannot be known without a clearer understanding of the long-term depot modernization requirements.

> ***Finding:*** The Army does not have a concept for the depot-of-the-future, which makes it difficult to understand the interactions of capital investments and to judge their merits on anything other than a case-by-case basis.

CAPITAL-INVESTMENT PROCESS

Resource Allocation

The Army allocates its funds for equipment and facilities to the activities in various ways. For equipment, DESCOM distributes the funds it receives according to two criteria. First, DESCOM assigns the highest priority to specific programs. Second, after the high-priority programs are funded, the remaining funds, if any, are distributed to the activities in "fair shares."

The allocation process for facilities begins each August when the depots brief DESCOM on their 7-year requirements, beginning 1-year out. (In FY86, for example, the depots briefed their requirements for FY88 to FY94.) Following these briefings, DESCOM then prioritizes the construction projects according to the following:

- Distribution Centers
- Projects that could not be carried out, although approved, from previous years
- Modernization of the force, mobilization-surge requirements, base operations, or special projects from AMC (in no particular order).

DESCOM then submits its prioritized MILCON requirements to AMC for final approval.

At this point in the process, funds for construction are often allocated according to a priority assigned by higher headquarters for the given year. As a result, capital-equipment projects that involve computers and information systems could receive the highest priority in one year, and, in another year, equipment to improve

safety or the environment could be favored. Unlike equipment, construction projects are not allocated to the activities according to fair shares.

Project Prioritization and Funding

Each of the Army maintenance activities has developed a long-term *Depot Integrated Modernization Plan* for its equipment and facilities. The plans cover 7 outyears, are updated annually, and are, in essence, "shopping lists" of individual equipment and facilities projects; however, they are not linked to any coherent strategy. DESCOM does not consolidate the individual plans into an overall command-wide plan. Indeed, one of the major objectives of the Ready-2000 initiative is to develop such a single, corporate modernization plan.

The priorities for construction and for equipment are also developed individually by depot. For equipment and construction projects exceeding $150,000, DESCOM requires a composite ranking based on an equal weighting of three separate procedures: net present value, internal rate of return, and the number of positions saved per investment dollar. For capital-investment projects that are not submitted to DESCOM – those valued under $150,000 – the depots may use other criteria. Both Anniston and Tobyhanna, however, use the payback method.

But the final decisions on the capital investments projects generally do not rest on economic calculations alone. The priorities are often revised by various boards reviewing the rankings. It is not unusual for depots to reprioritize their projects two or three times. As a result, there is no formal set of criteria that supplement the economic analyses and can be used for ranking the proposed capital investments at the depots.

In addition to the depot and DESCOM approvals for Army modernization projects, it is not unusual for several other agencies to be involved. For example, to obtain endorsement for an engine-diagnostic system, approval is required from Test, Measurement, and Diagnostic Equipment advocates at four Army Commands. Such a process is time-consuming and can result in inconsistent decisions.

Funding

It is not unusual for Army depots to have substantially different capital-investment programs. As an example, both Anniston and Tobyhanna Army Depots

have maintenance operations in the neighborhood of $200 million in revenues annually, yet their funding levels to purchase capital investments are quite different. In FY86, Anniston spent about $17 million, primarily for equipment under ACP, while Tobyhanna spent approximately $7 million.

The differences in ACP spending between these two depots has little to do with the differences in age and condition of their equipment, or the missions of the depots. Rather, it appears that Anniston is just more successful in developing and promoting its modernization projects.

Obligation Rates

Army depots are pressured to have high obligation rates for ACP funds spent on equipment. Originally, the ACP fund was to be removed from the pressure to obligate funds quickly, which occurred earlier when such funds were appropriated. However, the ASD (Comptroller) has been using the prior obligation rates of the Military Services to help decide on the future allocation of these funds among the Military Services. (As explained in Appendix B, Congress also has stressed the obligation of funds despite the fact that ACP equipment funds are exempt from such restrictions.) In turn, Army Comptroller representatives are requiring every depot to obligate its allocation of ACP funds quickly. If one activity obligates funds at a relatively low rate during the year, the Army Comptroller sometimes reallocates the remaining funds to quicker-to-spend activities – hoping they will spend these funds quickly as well.

> ***Finding:*** The pressure for high ACP obligation rates compels Army depots to fund the most expedient projects, not necessarily the best projects.

In response to the call for high obligation rates, Anniston has taken a number of steps. It writes its specifications for pieces of equipment early; then submits those specifications as soon as possible to the various outside approval points – DESCOM, AMC, and others – and to procurement. As a result, Anniston usually has its Requests For Proposals out sooner than many of the other depots. With this greater lead-time, it is more likely to have awarded contracts and expended funds within the fiscal year. And, in anticipation that it may be the recipient of a midyear

reallocation of ACP funds, Anniston will have already written technical specifications for still other equipment. Although this may result in "healthy" funding levels for Anniston, it is not clear that it is best for the total Army program.

CHAPTER 4

NAVY

INTRODUCTION

In this chapter we discuss first, the Naval Shipyards (NSYs), which are under the purview of the Naval Sea Systems Command (NAVSEA), and then the Naval Aviation Depots (NADEPs), under the purview of NAVAIR. These commands differ substantially in their approaches to operating maintenance facilities and in their strategies for modernization.

NAVAL SHIPYARDS

Modernization Strategy

Mobilization Workload and Posturing – NSYs

Following Navy mobilization guidance, NAVSEA has proposed a seven-step process to make plans for the resources in its shipyards to meet the maintenance workloads under mobilization:

- Identify the wartime scenario and its assumptions for maintenance.
- Compile operating-force requirements.
- Forecast peacetime and wartime workloads.
- Evaluate the adequacy of resources at the depots to meet wartime workloads.
- Recommend wartime-posturing actions.
- Incorporate actions into corporate plan.
- Implement decisions in the budget process.

However, this mobilization-planning process has not been implemented in the shipyards. Instead, NAVSEA has announced[1] that "National economic pressure on

[1]Naval Sea Systems Command. *Naval Shipyard Corporate Business Strategy and Plan.* 1 May 1987.

the defense budget is expected to force the selection of the many potential wartime mobilization scenarios to be that which is no greater than peacetime workload requirements." In effect, NAVSEA has defined the mobilization workload as no greater than the peacetime workload.

This definition is not consistent with the views of individual shipyards. Some of the shipyards are concerned that they may not be capable of meeting their mobilization-maintenance requirements. For example, at Mare Island NSY, an additional drydock may be needed to repair ships in time of mobilization. Currently, that shipyard does not have enough drydocks to work on all of the ships during a single operating shift. As a result, some of the ships have been worked on partially out of drydock – a less efficient operation.

The need for an additional drydock during mobilization depends on the wartime scenario and its assumptions concerning maintenance. On the one hand, a substantial increase in off-site repairs – teams sent to battle theaters, craftsmen sent to home-ported sites, and ships worked on at sea to a greater extent – would reduce the need for an additional drydock. On the other hand, if substantially more work is called for at Mare Island NSY during mobilization, an additional drydock appears to be needed. Without a defined wartime scenario – along with its implications for maintenance – Mare Island NSY's modernization plan may not meet wartime needs.

> ***Finding:*** The mobilization requirements for NSYs are not defined well enough to serve as a foundation for capital-investment decisions; instead, those decisions are made according to peacetime priorities.

Technology - NSYs

NAVSEA has not established any overall modernization strategy for the NSYs. This situation may be due, in part, to the unique nature of the work in the shipyards. Much of the work is done on board the ships and, thus, tends to be labor-intensive rather than capital-intensive. However, the work performed in the shop areas is amenable to improvements from capital investments, as are material handling, management information systems, and the interface between the ship and the shore – such as drydocks, cranes, and communications to the shop areas.

In February 1987, Coopers & Lybrand concluded that the NSYs do not have an adequate strategy for technology.[2] They reported that the ship community's long-term goals and objectives for capital assets do not address their needs adequately. Coopers & Lybrand also found that the shipyards' annual capital budgets were not guided by any technological strategy.

> ***Finding:*** There is currently no technological direction for capital investments in the NSYs.

Workload Plans – NSYs

As noted previously, NAVSEA is focusing on the peacetime workloads as a basis for modernizing the NSYs' facilities and equipment. In its *Naval Shipyard Corporate Business Strategy and Plan*, NAVSEA states that it expects wide swings in NSY workload over the next 10 years, declining until FY92 and then markedly increasing afterwards.

The expected pre-1992 drop in workload stems primarily from the Navy's introduction of the extended-overhaul cycle. Under this concept, ships enter the yards less frequently, and even then their "work packages" are reduced. More of the maintenance and repairs are done at sea by the crew of the ship or by crews of auxiliary ships. The increase in FY92 will arise because many nuclear ships are scheduled to be refueled beginning at that time.

Resource Plans

On the basis of these workloads and other considerations, NAVSEA has drawn up a 10-year plan for investing in facilities. Overall, this plan calls for $250 million per year to replace facilities when they reach 50 years of age.

NAVSEA has also tasked each NSY to prepare a 5-year plan for purchasing new or replacement equipment, based upon expected peacetime workloads and equipment condition. In FY88 and FY89, these plans call for equipment purchases, through ACP, totaling $160 million.

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[2]Coopers & Lybrand. *Capital Asset Management of Naval Shipyards*. Feb 1987.

Capital-Investment Process – NSYs

Resource Allocation

If the budget-authority level can accommodate all the funding requests, then NAVSEA allocates that budget to the shipyards according to their requests. If the budget authority falls short of that requested, NAVSEA invokes a variety of means to spread the shortfall among the shipyards.

In some cases, it has allocated the shortfall inversely to shipyards' workloads; in others, the shortfall has been distributed equally among the shipyards. In still other cases, NAVSEA has used economic analyses to decide on which projects should be deferred or canceled. Recently, NAVSEA drafted a new set of economic analyses, intending that the shortfalls be met on the basis of economic analysis in the future.

Facilities Prioritization and Funding – NSYs. In evaluating the need for, and the benefits of, new facilities, all NSYs follow NAVSEA's scoring system for rating construction projects that are funded under MILCON (i.e., projects that *exceed* $200,000 in cost). Figure 4-1 shows the form for rating these projects. Each project is rated on six elements, using a 0-to-5 scoring scheme for each element. Those ratings are then combined, using the weighting factors, to yield a total score for the project.

NAVSEA's six elements for ranking MILCON projects are defined as follows: (1) mandatory – projects that are critical to support the assigned mission and that have no feasible alternative to meet the project; (2) impact on Fleet support – projects that will support specific Fleet-assigned tasks; (3) degree of deficiency – projects that will correct or replace deficient facilities; (4) time sensitivity – projects that will meet a required operational date; (5) economic value – projects that have a rapid economic payback; and (6) quality of life – projects that will improve safety, the environment, and job satisfaction.

Although comprehensive, the elements are not mutually exclusive categories. In addition, the rating scheme can be simplified. To illustrate, elements 3, 4, and 5 can be addressed directly in an economic analysis. The degree of deficiency in existing buildings should be reflected in maintenance costs, a saving that should be taken into account in the calculation of benefits for a new facility. Furthermore, the time sensitivity on the completion of a building can be taken account of in the cost of construction itself: A building that is constructed substantially sooner than another

DATE: _____

RATER: _____

MILCON-PROJECT RATING SHEET

ACTIVITY: _____

FUNCTIONAL AREA _____

SHORE ACTIVITY _____ PROJECT NO. _____

PROJECT TITLE _____ INVEST. PROG. _____

RATING ELEMENT	POINT VALUE HIGH	POINT VALUE LOW	WEIGHTING FACTOR	WEIGHTED VALUE
1. MANDATORY-CRITICAL TO LONG-RANGE MISSION	5	0	25	
2. IMPACT ON FLEET SUPPORT	5 4 3 2 1	0	20	
3. DEGREE OF DEFICIENCY	5 4 3 2 1	0	15	
4. TIME SENSITIVITY	5 4 3 2 1	0	15	
5. ECONOMIC VALUE	5 4 3 2 1	0	15	
6. QUALITY OF LIFE	5 4 3 2 1	0	10	_____
COMMAND ADJUSTMENT TO POINT VALUE (+ OR –) (OPTIONAL)				_____
			TOTAL SCORE =	_____

RATIONALE FOR ASSIGNED POINT VALUE

ELEMENT 1 – _____

ELEMENT 2 – _____

ELEMENT 3 – _____

ELEMENT 4 – _____

ELEMENT 5 – _____

ELEMENT 6 – _____

RATIONALE FOR COMMAND ADJUSTMENT _____

PROJECT ASSIGNED SEQUENTIAL NUMERICAL PRIORITY FOR FY _____ OF NO. _____

FIG. 4-1. MILCON-PROJECT RATING SHEET

building of comparable size often costs more, certainly in discounted dollars. Thus, if these three elements are considered together, the weighting factor for economics would be 0.45, not 0.15.

Some of the other elements of NAVSEA's rating scheme for MILCON projects can also be consolidated. Mandatory or impact-on-fleet projects can be considered together as a strategic investment – where some of the benefits are intangible – and assigned a 0.45 weight. Quality-of-life considerations, however, would remain as a separate category, with a 0.10 weighting factor. In Chapter 7, we show how these difficult-to-measure benefits can also be evaluated in an extension of a single economic analysis.

NAVSEA has had its MILCON program for shipyards reduced substantially. Instead of receiving $250 million per year as planned, NAVSEA received only $20 million in FY87 and is scheduled to receive no MILCON funds in FY88.

The effects of not having any MILCON funds go far beyond postponing new facilities. In some cases, it even leads to increased costs. For example, Norfolk NSY has been planning to extend the tracks around its drydocks so that fewer portal cranes would be needed. Over the next 5 years, Norfolk NSY will be replacing nearly a dozen of these cranes at a cost of about $3 million per crane. By extending the tracks around the drydocks, an investment substantially under $1 million, it could forego the replacement of two cranes – saving about $6 million. However, the extension of the tracks only can be financed with MILCON funds, but these funds have "dried up." Consequently, Norfolk NSY may be forced to replace the full set of portal cranes, using ACP funds, even though this would be more costly than the track-plus-cranes alternative.

As another example, Mare Island NSY has stepped up its use of minor construction funds under the ACP. As a substitute for larger buildings that require MILCON funds, Mare Island NSY has constructed a number of small, prefabricated buildings using minor construction funds. Such temporary buildings were constructed for a variety of shops near the drydocks even though a smaller number of larger buildings might have been more cost-effective.

> ***Findings:*** The use of separate accounts, such as MILCON and ACP, dictates that depot modernization programs be planned project-by-project, rather than follow an overall strategy. Also, unbalanced funding levels among the various accounts may

frustrate a comprehensive modernization strategy and result in noneconomic capital investments.

Equipment Prioritization and Funding. NAVSEA's priority system for equipment differs somewhat from its system for facilities. The primary criterion is payback period – i.e., the number of years required to recover the investment cost. NAVSEA has established a 7-year payback period as the maximum that is acceptable for equipment projects.

Some noneconomic considerations also get factored into the final decision. For example, Mare Island NSY considers mandatory programs, impact in terms of work stoppages and safety hazards, as well as usage or expected utilization rate.

Once a shipyard has set its priorities for equipment, projects costing more than $100,000 are submitted to NAVSEA for review and approval.

Use of ACP to fund equipment purchasing at NSYs has increased dramatically in recent years. From FY83 through FY86, budgetary authority averaged $88 million, but in FY87 through FY89 that authority is planned to average about $184 million.

Operationally, the ACP funding process may be forcing quick, noneconomic decisions. At one shipyard, there is intensive pressure to obligate ACP funds within the fiscal year that they have been received. In principle, the ACP funds for equipment do not expire each year, but the obligation rate – a remnant of the pre-ACP days – is still "driving" the purchase of particular pieces of equipment. In fact, during our visit, one activity received an additional $5 million to spend on equipment in FY87. Because some of these funds were not expected, they may not have been spent very wisely in the 3 months that remained in that fiscal year.

Finding: The pressure upon NSYs to obligate ACP funds quickly may lead to noneconomic investments.

NAVAL AVIATION DEPOTS

Modernization Strategy – NADEPs

Mobilization Workload and Posturing – NADEPs

NAVAIR, like NAVSEA, has proposed a seven-step process to plan for the resources it needs to meet its aviation workloads during mobilization:

- Identify the wartime scenario and its assumptions for maintenance.
- Compile operating-force requirements.
- Forecast peacetime and wartime workloads.
- Evaluate the adequacy of resources at the depots to meet wartime maintenance workloads.
- Recommend wartime-posturing actions.
- Incorporate decisions into corporate plan.
- Implement corporate plan in budget process.

Unlike NAVSEA, however, NAVAIR has implemented at least part of its mobilization planning process.

During mobilization, NAVAIR is expecting that more repairs will be required on engines and components, and less on airframes, than in peacetime. To meet such workloads, NADEP Norfolk and NADEP Alameda, for example, would expand from a single-shift operation during peacetime to multiple shifts. Since the work force is planned to only work a 60-hour week, additional labor would be required to work the additional shifts. The equipment and facilities in place during peacetime basically sets the capacity of the depots during wartime.

There are a number of factors that influence the viability of this approach. The NADEPs need the appropriate peacetime mix of airframe-component-engine work. Otherwise, they may not be able to provide the required support during mobilization. Given NAVAIR's recent emphasis on contract support from the private sector, however, there is no assurance that unconstrained competition will result in the desired workload mix. For the NADEPs to maintain a minimum technical competence on a specific aircraft – e.g., the F-14 – they may need to work on a certain minimum number of such aircraft each year in peacetime. But the competitive

process will most likely not satisfy this mobilization-derived requirement unless it is compelled to do so. If the process is unconstrained, the goals of competition and mobilization are likely to conflict.

> ***Finding:*** Unconstrained competition may not result in a viable organic base for accomplishing NAVAIR's depot-maintenance mobilization workload.

Additionally, the required levels of work under mobilization may not be achievable with the resources that are expected to be available at that time. As an illustration, representatives from NADEP Norfolk believe that they would face a bottleneck in repair parts and that the war reserves would be inadequate to meet wartime workloads. They also expressed skepticism about their ability to hire and train the needed labor to satisfy the requirements for a multiple-shift operation – 1,100 additional people at NADEP Norfolk alone.

Finally, NAVAIR has stated that "... programming policies and guidelines have not always been considered totally adequate to determine specific levels of required industrial facilities, equipment, and manpower."[3] In fact, neither NADEP Alameda nor NADEP Norfolk know whether their equipment and facilities could support a multiple-shift operation to meet mobilization workloads.

Technology - NADEPs

In 1984, the Austin Engineering Company completed an evaluation of the condition of the in-place equipment in the NADEPs. As part of that effort, the Austin Company commented on the NADEPs' current level of technology and its adequacy in maintenance and repair of Navy aircraft. In its report, the Austin Company called for improvements in various operations, including: material handling and storage; stripping and paint equipment; machine shop equipment; as well as in computer-aided design and manufacture, office automation, and centralized data management. That effort, however, focused on individual NADEP operations and, in doing so, overlooked strategic technological goals that affect overall processes.

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[3]See Naval Aviation Logistics Center (now Naval Aviation Depot Operations Center). *Navy Industrial Fund Corporate Capital Investment Plan.* Vol. 1. 16 Jan 1987.

In April 1986, the Naval Aviation Depot Operations Center (NADOC) developed a command-wide approach for applying new technologies. Specifically, NADOC assigned to each of the six NADEPs a set of technologies that it would follow and report on to the other NADEPs. For example, NADEP Alameda was assigned the lead in antenna repair/test, magnetic recording devices, industrial laser applications, nondestructive inspection of engines, and pneumatics/hydraulics (high pressure).

In March 1987, Coopers & Lybrand concluded[4] that the aviation community's long-term goals and objectives for capital assets do not identify their needs adequately. Also, they judged that annual capital budgets have not been guided by any strategy for technology. Finally, they indicated that the aviation community has focused too much on individual operations rather than on the overall repair process – noting that the greatest improvements are usually made by taking a systems approach rather than a project-by-project approach to repair operations.

In terms of applying specific technologies, NADOC representatives have indicated that they would like to see Group Technology applied to the repair process. In simple terms, Group Technology is a way of organizing the shops around similar parts or processes, cutting across specific functions – such as welding or machining. Thus far, Group Technology only has been applied to manufacturing in the NADEPs.

For example, NADEP Norfolk has applied Group Technology to the manufacture of critical engine parts by grouping these parts into manufacturing cells on the basis of the shapes of the parts. In this effort, 10 machines were combined into one such cell to produce cylindrical-shaped parts for Navy aircraft. The results were dramatic: reduced throughput time on the manufacture of landing gear parts from 75 days to less than 40 days, improved quality of production, increased control, and improved morale.

Even with these successes, NADEP Norfolk has not fully considered expanding the applications of Group Technology. The extension of Group Technology from the manufacture of engine parts to the repair of those parts has not been contemplated. In fact, capital investments have recently been made that run counter to those

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[4]Coopers & Lybrand. *Naval Depot Operation Center's Corporate Capital Investment Plan.* Mar 1987.

required by Group Technology – a new consolidated machine shop is one such example.

> ***Finding:*** Although new technologies are being introduced into the NADEPs, there is no technological direction linking them.

New Directions

The NADEPs have recently established a corporate plan – following the recommendations of Coopers & Lybrand to establish more business-oriented methods and procedures – that contains elements of a strategy, including:

- Increase productivity by 20 percent over the next 5 years.
- Identify cost elements to be utilized in competitive bidding.
- Integrate determination of workloads with resource planning.
- Establish a mechanism for gain sharing and group awards in personnel management.
- Consolidate engineering and logistics functions.

The NADEPs also have adopted another recommendation of Coopers & Lybrand on the purchase of equipment: set aside 10 percent of funding to purchase equipment that will establish new capabilities to compete against the private sector for new workloads. These "strategic buys" would be identified by the management of the NADEPs and such purchases would be made in an attempt to compete successfully against the private sector and other NADEPs. Like the private sector, however, the NADEPs may purchase these pieces of equipment but the workload may not materialize. Paradoxically, the buy-ahead-equipment philosophy has been established to help compete against the private sector for new peacetime workloads, but it is not used to help meet requirements for mobilization workloads.

> ***Finding:*** NAVAIR's capital-investment decisions are based principally on peacetime, not mobilization, needs.

Capital-Investment Process – NADEPs

NAVAIR allocates MILCON and ACP funds to its NADEPs on the basis of its budgetary authority and the various means it has of distributing those funds. If the budgetary authority satisfies the NADEPs' requests for modernization, then the funds are allocated accordingly. If the requests from the NADEPs exceed the

budgetary authority, NAVAIR uses a variety of approaches for allocating the shortfall. For example, projects may be given lower priority if they are unrelated to the support of directed programs. Also, those NADEPs that traditionally obligate their funds relatively slowly may receive the largest cuts. Finally, NAVAIR may use the economic analyses to reduce funds: projects below a certain threshold of economic worth may be reduced or canceled.

Project Prioritization and Funding – NADEPs

The NADEPs make their requests for facilities and equipment according to rules and procedures established by NAVAIR. These approval processes differ between facilities and equipment, and each, therefore, is discussed in turn.

Facilities – NADEPs. When setting requirements for facilities in peacetime, the NADOC uses a mathematical model to translate workload into square footage of facilities. This formulation – referred to as the Austin mathematical model – takes the current technological processes in the early 1980s, and shows the relationship between workload and space at the work-station level.

To generate the peacetime square footage required, the Austin model is applied to the peacetime workloads that can be expected if maintenance is fully funded – called "unconstrained workloads." Each NADEP is required to use the model to make sure that its requirements for facilities are consistent with those based upon unconstrained workloads.

NAVAIR has developed a 10-year plan to modernize the NADEPs. That plan is based upon the Austin-derived requirements for peacetime facilities, as described above, and the physical evaluation of the condition of the existing facilities – also performed by the Austin engineering firm. The differences between the facilities required and those in place provide the funding levels needed to modernize the facilities, either by new construction or by improvements.

Applying the above approach indicates that all NADEPs would require $120 million per year for the 10-year period. The specific requirements for each depot would, of course, vary by depot. For example, NADEP Norfolk would require $20 million per year, while NADEP Alameda would require $29 million per year.

In terms of the priorities placed on the MILCON projects, various procedures are followed. It is not unusual for the highest priority to be given a project that is

needed to meet a new capability, with a lower priority given to facilities that are designed to replace deficient buildings and structures. For normal replacements of facilities, an economic analysis is performed following Naval Facilities Engineering Command (NAVFAC) Publication P-442, *Economic Analysis Handbook*, 1 June 1986. That publication calls for the calculation of payback periods – the time that discounted benefits take to just recoup investment costs – for all new facilities, although equivalent net present values are calculated also.

Like NAVSEA, NAVAIR also has had its MILCON program substantially reduced. The effects of that reduction are significant for some of the NADEPs. For example, a much needed 10-year, $29-million per year modernization program has been stretched out over 26 years at NADEP Alameda.

To offset the reduction in MILCON funds, NADEP Alameda, for example, has sought other sources of funding to help maintain its buildings and structures. This activity has made extensive use of ACP funds for minor construction projects, including $7 million in FY87, with an additional $17 million planned for the period FY88 through FY90.

> ***Finding:*** The dearth of MILCON funds may result in the NADEPs making uneconomic investments.

Equipment – NADEPs. As with facilities, the NADEPs also use a bottom-up approach to determine which equipment needs to be purchased. That process is as follows:

- The NADEPs submit their requirements for equipment and supporting economic analyses to NAVAIR through NADOC.
- NAVAIR and NAVFAC then review those requirements from the standpoint of workload, economics, and existing equipment.
- The NADEPs modify their requirements based on the outcome of the NAVAIR-NAVFAC reviews.
- If the authorized funding cannot satisfy all the requests, then NAVAIR and the Navy Comptroller allocate the available funds to individual projects.

The NADEPs are required to submit to NADOC all requests for equipment that cost more than $300,000. NADOC, in turn, needs approval from NAVAIR for projects exceeding $1 million in value.

The criteria for prioritizing individual projects is straightforward. Generally, the highest priority is assigned to projects that are mandated by NAVAIR or by other sources outside the NADEPs. A somewhat lower priority is assigned to equipment that is needed for new facilities – called "collateral equipment," followed by equipment requested to replace old equipment or to improve productivity of existing equipment. In addition, 10 percent of the funds for equipment are set aside for strategic investments – purchases of equipment designed to establish a new capability to be used to compete against the private sector for possible new workload.

Equipment to replace old equipment or improve the productivity of existing equipment is by far the main concern of the NADEPs. Coopers & Lybrand recommended that the NADEPs set aside about 70 percent of their funds for equipment for these purposes.

All equipment proposed for replacing old equipment or to increase productivity requires an economic analysis. As an example, NADEP Norfolk requires a 5-year payback on its requested equipment, while NADEP Alameda uses a 4-year payback. The strengths and weaknesses of this methodology are discussed in more detail in Appendix C.

As described in Appendix B, the ACP has substantially increased the amount of funds made available for new equipment. In the FY70 – FY83 period, before ACP was in effect, the NADEPs as a whole never received more than $30 million in a year to purchase equipment. Over the period of FY84 to FY87, with the ACP fully in effect, the NADEPs received an average of $70 million per year.

NAVAIR earmarks ACP funds for each NADEP. Based on the effects of such funding, each NADEP sets its own man-day rate to its customers. ACP surcharges may be set at different levels to reflect the differences in the condition of the equipment for the NADEPs. The NADEPs are sensitive to the effects of their ACP funding on their man-day rates.

For example, NADEP Norfolk has been varying its purchases of equipment to lessen the impact that ACP funding has on its man-day rates. In FY85 and FY86, NADEP Norfolk's ACP funding was $17 million or more. However, in both FY87 and FY88, NADEP Norfolk management reduced the number of requests for ACP funding in order to keep that funding under $13 million.

In general, the ACP is not administered in the way it was intended for the purchase of equipment. The NADEPs are judged on their ability to obligate their authorized funds in the year they have been received. Since the ASD (Comptroller) tends to allocate ACP funds to the Military Services for a given fiscal year based upon their obligation rates in prior years, the Naval aviation community has an incentive to keep obligation rates as high as possible. This emphasis on obligation rates to judge the NADEPs' effectiveness with the ACP may result in perverse economic effects. For example, NADEP Alameda reports that the lead-time to award a contract for a piece of equipment valued over $1 million was about 300 days in FY87. On the other hand, for lower valued and lower technology equipment, such lead-times were substantially shorter.

> ***Finding:*** The emphasis on obligation rates may pressure the NADEPs to purchase quicker obligating, lower valued, and lower technology equipment.

CHAPTER 5

AIR FORCE

MODERNIZATION STRATEGY

Mobilization Workload and Strategy

The basic Air Force plan for mobilization is that in the first 30 days, all aircraft in the depots will be repaired as quickly as possible. After this initial surge, components and engines will begin to flow back to the depots for repair – with the workload for components and engines expected to increase from their peacetime levels, and the workload for airframes to decrease. The manufacture of critical parts is also anticipated to increase during this period.

The Air Force expects to respond to this increase in wartime workload by more intensive use of existing depot capacity (i.e., the 2nd and 3rd shifts). To meet the labor requirements of a three-shift operation, the Air Force has identified retired maintenance workers, surveyed local labor markets, and planned for the training of newly hired civilian personnel. (An additional labor requirement will result from increased use of field teams.) However, the other resources needed for mobilization of the depots (e.g., equipment, facilities, repair parts) have not received nearly this level of attention.

Difficulties

There are some potential resource bottlenecks in this plan for meeting wartime workloads. Several maintenance areas are already working more than one shift. In some cases, this results from the nature of the industrial process, painting for example; in others, it may be the result of equipment bottlenecks. The adequacy of the equipment and facilities at the Air Logistics Centers (ALCs) to meet mobilization requirements is, therefore, questionable. However, the Air Force is now looking at the adequacy of these resources. Specifically, it is working with a regression-derived depot-sizing model to assess the capabilities of the depots in

peacetime and wartime. Until this model is routinely used, however, capital-investment decisions are likely to be made without explicit reference to wartime needs.

Another concern is that the estimates of wartime workloads are highly unstable. At two recent workload conferences, one ALC, for example, had its wartime workloads substantially changed. After one conference, it appeared that the peacetime workload and manning level for that depot were insufficient to serve as a base for meeting the wartime-surge requirement. Six months later, by contrast, the peacetime posture of that depot was much too large to be justified on the basis of mobilization requirements. We understand that a change in the methodology for estimating the wartime workloads contributed to the instability in these estimates. Without stable, credible estimates of wartime workloads, however, mobilization planning cannot serve as a useful guide for making capital-investment decisions.

> ***Finding:*** The Air Force cannot currently make capital-investment decisions on the basis of wartime needs because: (1) the workload estimates are not credible and (2) the effect of those workloads on equipment and facilities is not sufficiently well understood.

Technology

The Air Force is applying a variety of innovative technologies in its depots. One of the most promising of these new technological concepts is Group Technology. Oklahoma City ALC has applied Group Technology to a major part of its operation: engine repair and overhaul.

By way of background, the building that housed Oklahoma City's engine work had a major fire in 1984. As a result, all of the equipment used in the operation was removed from the building. The ALC took that occasion as an opportunity to rethink the way it was doing engine repair and overhaul.

This ALC had worked with Group Technology to a limited degree in the past and decided to expand its use when it redid its engine operation. For 1 year following the fire, ALC personnel worked with representatives from Oklahoma University to apply the principles of Group Technology to its engine division.

This involved:

- Defining the concept of a Modular Repair Center. This concept groups parts with similar characteristics and repair processes, assigns all the machines necessary to the processes, and appoints a single manager in charge of each center.
- Developing an alphanumeric code system that defines the resources required to overhaul each jet engine component and part and distinguishes among similar machines with respect to their capability and capacity.
- Applying a model to simulate alternative shop layouts, using the above concepts as well as data on work documents and material-handling design.

This application of Group Technology required an additional $3 million investment – primarily for decentralized automated storage and retrieval systems. No additional equipment was required. The benefits included a 2 percent increase in the productivity of direct labor per year and a 55 percent, one-time reduction in throughput time. Equipment utilization also increased.

In FY88, Oklahoma City ALC is planning to improve further its application of Group Technology in the engine division by introducing, among other things, an inventory-tracking system. Beyond that, this activity will be seeking additional application in areas other than the engine division.

> ***Finding:*** Group Technology has the potential to substantially improve depot-maintenance performance.

Although the Air Force has had numerous programs to modernize the depots, an Air Force Logistics Command (AFLC) strategy on the introduction of new technology has not as yet been defined. The current approach is to subsume it under the new Quality Process Improvement Program managed by Headquarters AFLC.

CAPITAL-INVESTMENT PROCESS

Resource Allocation

AFLC distributes ACP funds for equipment to the ALCs in the following way. It gives first priority to the outfitting of new buildings. Then it satisfies special AFLC-directed projects. Of the remaining funds, 10 percent is set aside for new scientific and technological initiatives – the ALCs compete for these funds – and

the remainder is allocated (following a formula) among the ALCs to be spent at their discretion.[1]

The discretionary ACP expenditures are approved at one of two levels. If the value of the proposed equipment is below $300,000, then the ALC has final approval. If the equipment is valued at $300,000 or higher, then the ALC needs the concurrence of AFLC. In both situations, economic analyses are required.

In allocating MILCON funds, however, all projects need to be approved by both AFLC and ALC before being sent to the Air Staff.

Project Prioritization and Funding

To illustrate the type of modernization planning that occurs at the ALCs, we draw upon Oklahoma City's Technology Enhancement and Modernization of Plant Operations (TEMPO)-97 program.

TEMPO-97 is an integrated, time-phased modernization plan for the entire ALC. It groups each of the projects by category of expenditure (minor construction, MILCON, Repair Technology, etc.); and it shows the sources of funds and when the project is scheduled to be initiated. Listed below are several categories of expenditures in TEMPO-97 and an illustrative project within each category:

- Initial Outfitting of Equipment: repair facility in FY89
- Equipment Purchases: high-speed grinder in FY90
- Minor Construction: alterations to overhead monorail hoist in FY88
- Maintenance and Repair Projects: maintenance of roof to Building 3001 in FY88
- MILCON: bearing-overhaul facility in FY92
- Productivity, Reliability, Availability, Maintainability: for laser holography in FY88

[1]The formula for this allocation weights the factors as follows: revenues – 10 percent, depreciation – 20 percent, and age of equipment – 70 percent. The overall effect of this formulation is to give priority to the ALCs that have the oldest equipment.

- Maintenance Sponsored Technology: for engine assembly with robotics tooling in FY89
- Repair Technology: noncontact laser in FY93.

This program has successfully integrated the planning for the diverse capital investments at Oklahoma City ALC. However, the splintering of the financial accounts – with their different criteria for approval – may still interfere with carrying out the overall modernization strategy.

> ***Finding:*** An ALC-wide approach to setting priorities for capital investments can be successful; its success, however, may be limited by the existing funding structure.

All of the ALCs use the concepts of net present value and payback to evaluate their MILCON and ACP investments. However, because these methodologies make it difficult to assign priorities across divisional lines within each ALC, not to mention across ALCs, the Air Force is now reconsidering their use.

In FY87, the Air Force directly received more than $160 million for the modernization of its five ALCs – down slightly from the average of $173 million in FY85 and FY86. Of the FY87 total, $85 million was for equipment – down from an average of $117 million in FY85 and FY86. Funds for technology increased dramatically for FY87: to $35 million, up from an average of $21 million in the previous 2 years. At the same time, funds for facilities were about $42 million in FY86 and in FY87.

Although the Air Force has received substantial levels of funding for equipment, it apparently is experiencing two problems in this area. First, the Air Force's ACP funds were reduced substantially in FY87 because its obligation rate was considered too low – a situation that was supposed to have ended when the ACP replaced appropriated funds for this purpose. Second, some of the ALCs have indicated that contracts have been awarded to low-bid contractors who did not have the proper capabilities. Evidently, the contracting offices have not included past-experience clauses in requests for proposals, which would have eliminated unqualified, low-bid contractors.

CHAPTER 6

MARINE CORPS

MODERNIZATION STRATEGY

Mobilization Workload and Posturing

The Marine Corps has a well-defined scenario to plan its maintenance workload for mobilization. For the first 90 days of mobilization, depot workload will not surge. As a result, some depot personnel will be assigned elsewhere. Some will be sent to points of embarkation to calibrate and check the weapons that will be going into combat. Others will be assigned to help in the preparation of war reserves during this period.

In the fourth month following mobilization, however, the Marine Corps expects a surge in workload. Specifically, the increased workload would stem from retrograded rifles and antitank missiles that need to be made combat-worthy once again and from foreign military sales.

Labor

To meet the surge in workload in the fourth month, the depots will operate on a single 10-hour shift, 6 days a week. The Marine Corps estimates that 100 additional people would need to be hired and trained at each depot during mobilization for this purpose. No additional equipment or facilities are expected to be needed to meet this relatively minor surge in workload.

Even with such a modest increase in the required labor to meet this surge, the Marine Corps has expressed concern about hiring and training the additional people. For example, the Marine Corps cites that the labor participation rates of women and teenagers are much higher in the last 10 years than they were earlier; such a situation, it is feared, might create a shortage of labor for the depots under mobilization. In fact, the Marine Corps indicated that the Military Services are jointly studying this question.

Competition

Unlike NAVSEA and NAVAIR, the Marine Corps has not experienced major increases in competition with the private sector for its current workload. Thus, the Marine Corps has not had any major shrinkage in its peacetime workload. As a result, the Marine Corps is confident that it can maintain the technical competency necessary to meet the mobilization demands for maintenance and repair.

Technology

The Marine Corps currently is not undertaking any major modernization of its depot equipment. Although equipment is being bought to replace existing pieces of equipment, major new technologies are not being introduced.

The Marine Corps did indicate, however, that it has worked with the Joint Technology Exchange Group in examining various technologies, including the possible application of lasers and a robotic painting operation. The latter would require a new facility as well as new equipment.

CAPITAL-INVESTMENT PROCESS

Requests for equipment and facility investments are proposed by the individual depots. In accordance with NAVCOMPT (Navy Comptroller) Instruction 7600.27, *Capital Investment Program for Industrial Fund Activities*, 4 August 1982, each request is supported with benefit and cost information.[1] However, the depots do not perform a formal economic analysis of each request.

The Marine Corps does not employ a formal economic analysis for several reasons: Marine Corps headquarters interacts frequently with the depots to help set the priorities; there are few requests for capital investments, making prioritization of the projects fairly easy; and Marine Corps headquarters believes that the value of these investments is so low that a formal economic analysis is not justified, citing various cases of investments valued at only $50,000.

In FY87, the ACP funded about $8 million of capital investments for both Marine Corps depots. Of that amount, approximately $2.6 million was spent on the modernization of equipment and another $1.4 million for minor construction. The

[1] Also, Marine Corps Order 7000.12A. *Economic Analysis*. 6 October 1986: a recent guideline that uses present-value calculations and considers nonquantifiable benefits as well.

balance, nearly $4 million, was earmarked for software and hardware enhancements for the development of a workloading-scheduling system.

CHAPTER 7

ECONOMIC ANALYSES OF DEPOT INVESTMENTS

INTRODUCTION

This chapter examines the economic analyses used to weigh the merits of capital investment. It begins by describing DoD and Office of Management and Budget (OMB) guidelines for conducting economic analyses. Then it discusses the approaches used by both the Military Services and the private sector, and concludes with a brief assessment of their current practices. The basic economic concepts are discussed in Appendix C.

DoD AND OMB GUIDELINES

DoD has provided the Military Services with three distinct guidelines for evaluating capital investments. The productivity investment fund (PIF), established by DoD Instruction 5010.36, *Productivity Enhancing Capital Investment*, 31 December 1980, funds investments of $100,000 or more in facilities that offer savings in personnel and materials, and requires a *4-year payback period.*

A second OSD-sponsored program, productivity-enhancing capital investment (PECI), specifies a *2-year payback period* for capital investments in off-the-shelf commercial equipment of $100,000 or more. That program, however, has not been used very much for depot maintenance equipment since the advent of the ACP in FY83.

All other sources of funding for capital investments in depot maintenance are subject to DoD's general guidelines on economic analysis, as specified in DoD Instruction 7041.3, *Economic Analysis and Program Evaluation for Resource Management*, 18 October 1972, which suggests the use of net present value (NPV) but does not exclude the use of other criterion.

Additional guidance has been provided by OMB – referred to in DoD Instruction 7041.3 quoted above – on discounting and on the calculation of benefits and costs. For the purchase of assets, OMB Circular No. A-94, *Discount Rates To Be*

Used in Evaluating Time-Distributed Costs and Benefits, 27 March 1972, specifies that benefits and costs first should be considered in inflation-adjusted or constant-dollar terms, then they should be discounted using a 10 percent discount rate – which represents the average rate of return on private investment, before taxes and after inflation. That circular is being revised at this time.

Comments on Guidelines

The 10 percent discount rate established in OMB Circular No. A-94 was largely derived from a study by J. A. Stockfisch, *Measuring the Opportunity Cost of Government Investment*, Institute for Defense Analyses Research Paper P-490, March 1969. In this paper, Stockfisch indicates that the rate of return generated by private, physical investment in the private sector was about *12 percent* over the *1949–1965* period – *including inflation.* Because inflation was about 2 percent at the time of Stockfisch's study – based on the deflator for the Gross National Product – he concluded that the *inflation-adjusted* rate of return in the private sector was about *10 percent* in 1965 (12 percent nominal rate minus 2 percent inflation rate).

The 10 percent discount rate, however, may not be applicable to today's conditions. With a 4.5 percent inflation rate for 1987 and a nominal rate of return close to 12 percent, the 10 percent estimate of the inflation-adjusted rate of return in the private sector seems to be too high.

MILITARY SERVICE PRACTICES

The Military Services use markedly different economic analyses for capital investments. These practices are discussed in turn.

Army

For equipment that is funded through the ACP, DESCOM reviews projects that exceed $150,000 and the depot commander approves those under $150,000. DESCOM also evaluates all MILCON-funded construction and requires that an economic analysis be performed on these capital investments (Army Regulation 5-4, *Economic Analysis*, August 1982).

The Army's economic analysis of its capital investments follows a three-pronged approach. First, it ranks the projects according to their internal rate of

return (IRR). Then, it ranks the projects by their NPV. The third ranking of projects is based upon the labor-saving efficiency of investment.

After these lists of priorities are completed, the three individual criterion scores are added together and then ranked in ascending order. It is this composite ranking that is used to prioritize the capital investments projects exceeding $150,000 in value.

Tables 7-1 and 7-2 describe the Army's triple-ranking procedure by summarizing the particulars of three hypothetical projects. In these examples, the investment costs and the hurdle rates are the same, but the expected lives and the annual savings differ.

TABLE 7-1

ARMY PROJECTS

Factors	Projects		
	A	B	C
Cost	$100,000	$100,000	$100,000
Hurdle rate	10%/year	10%/year	10%/year
Expected life	20 years	15 years	10 years
Overall annual savings	$10,000	$15,000	$20,000
Personnel saved per year	1 position	2 positions	0 positions

Results

It is not surprising that the rankings of these three projects using the IRR and NPV criteria are the same: C, B, and A. Indeed, these two criteria will yield identical investment decisions under most circumstances.

The third criterion, however, shifts the previous C-B-A rankings to B, A, and C. The number of positions saved by the investment depends upon the level of the total annual savings from all sources as well as upon the labor-saving properties of that investment. In our hypothetical example, no labor was saved in Project C even though its total annual savings were higher than those of the other two projects. As

TABLE 7-2

ARMY PROJECT EVALUATIONS

Project	Criterion							
	Internal rate of return		Net present value[a]		Investment per position saved		Composite	
	Measure	Rank	Measure	Rank	Measure	Rank	Measure[b]	Final rank
A	9.4%	3	0.95	3	100,000	2	8	2
B	15.1%	2	1.29	2	50,000	1	5	1
C	19.9%	1	1.42	1	∞	3	5	1

[a] The Army uses the ratio of the present value of savings-to-investment cost to measure this concept.

[b] The composite measure is the sum of the rankings from the individual criterion.

a result, whereas Project C was rated first by the IRR and NPV concepts, it is now rated last by the concept of the labor-saving efficiency of investment.

The composite ranking of these three investments was not decisive, which commonly occurs when multiple criteria are used to evaluate investments.

Comments on Army Analysis

The criterion of the labor-saving efficiency of investment or investment per position saved has doubtful economic substance. The rate of return on a capital investment should take into account all the sources of savings – machines, floor space, labor, utilities, and other costs – not labor alone. On economic grounds, it is difficult to argue that the savings on labor should be given greater weight than savings derived elsewhere.

The composite ranking, in addition to being indecisive, does not preserve relative rankings among projects as more projects are added. In our example, the two equally ranked projects could be unequal if projects were added that ranked below them in IRR and NPV, but above one of them in labor savings. Thus, two projects whose intrinsic worth were unchanged could go from equally ranked to unequally ranked by the mere addition of other projects. This is not characteristic of a robust methodology.

Navy

Capital investments are addressed somewhat differently by NAVSEA, NAVAIR, and the Marines Corps.

NAVSEA

NAVSEA reviews certain capital-investment proposals from its shipyards. In the case of equipment that is funded through the ACP, NAVSEA reviews those projects that exceed $100,000 and the commander of the shipyard can approve ACP-funded equipment projects valued under $100,000. All construction projects funded under MILCON must be submitted by the shipyard to NAVSEA for review.

NAVSEA's *Naval Shipyard Corporate Business Strategy and Plan*, dated 1 May 1987, states that either the payback criterion or NPV can be used to make capital-investment decisions. For equipment, the NAVSEA business plan establishes a ceiling of 7 years within which investment costs must be recouped; benefits are undiscounted to calculate this measure. In short, equipment that cannot recoup investment costs within this period are not considered. However, NAVSEA is in the process of rethinking this payback criterion for the evaluation of its ACP-funded investments in equipment.

NAVSEA, using yet another concept to evaluate its investments in facilities, scores six separate factors to rank the worth of building projects, including mission-mandated items, legally dictated priorities, and economic analyses. Each of these factors is given a score between 0 and 5 depending upon its level of severity. Afterwards, an overall or composite rating is determined by weighting the individual, factor-specific scores.

The economic factor is scored according to the scheme in Table 7-3. Note that the 0-to-5 scores are mapped to either an NPV concept – expressed as a ratio of discounted savings-to-investment flows – or to the point at which its accumulated, discounted savings just pay back the investment costs. Following this approach, the highest score – point value of 5 – is given to a MILCON project that has a present value of savings which is three times investment costs, or to that project that has its discounted savings just matching its costs in less than 3.9 years. This either-or approach follows instructions from NAVFAC Publication P-442, *Economic Analysis Handbook*, 1 June 1986.

TABLE 7-3

SCORING OF ECONOMIC ANALYSIS
FOR 25-YEAR-OLD BUILDINGS

Point value	Net present value[a]	Payback[b]
5	Over 2.9	Less than 3.9
4	$1.9 < X \leq 2.9$	$6.8 > X \geq 3.9$
3	$1.5 < X \leq 1.9$	$9.8 > X \geq 6.8$
2	$1.2 < X \leq 1.5$	$14.8 > X \geq 9.8$
1	$1.0 < X \leq 1.2$	$25 > X \geq 14.8$
0	$X \leq 1.0$	$X > 25$

[a] NAVSEA uses the ratio of the present value of savings-to-investment to measure this concept for buildings.

[b] Benefits are discounted to calculate investment-recoupment period.

The score given for the economic analyses of a MILCON project receives a 0.15 weight as its contribution to the composite rating of that project. For example, if the particular MILCON project receives an economic-analysis score of 5, the contribution of this factor to the composite score of that project would be 0.75 – score of 5, weighted by 0.15.

NAVAIR

In the case of equipment that is funded through the ACP, NAVAIR reviews those projects that exceed $300,000 and the commander of the depot can approve ACP-funded equipment projects under $300,000. All construction projects funded under MILCON must be submitted to NAVAIR for review.

The NADOC requires the NADEPs to use the payback period for their economic analyses of capital-equipment investments. NADEP Alameda, for example, uses a 4-year payback criteria when it replaces old equipment or purchases new, productivity-improving equipment – about 80 percent of the total capital-equipment decisions. This criteria is not used on strategic capital investments or on equipment needed to outfit new buildings.

Like NAVSEA, NAVAIR relies on yet another concept to evaluate its investments in buildings. It uses the payback criterion, but in making the calculation it discounts the benefits from the investment. It also calculates NPVs for this purpose. These procedures are consistent with NAVFAC's *Economic Analysis Handbook*.

Marine Corps

The Marine Corps does not employ a formal method to analyze its capital investments. Most of the capital investment projects involve replacement of old equipment. For such investments, costs and benefits are documented, but no other calculations are performed.

Comments on Navy Investment Analysis

The Navy uses several criteria to evaluate its capital-investment decisions. For equipment in the aviation depots and shipyards, it uses a short-term payback criterion. This criterion may be biased against new technological investments that have long-term benefits. For maintenance facilities, it uses NPV – or its equivalent payback period calculated with discounted benefits – with a 10 percent discount rate that may be too high at this time. In addition, the weight given to the economic analysis is very low.

The Navy is currently reviewing its decision criteria on depot-level capital investments. In fact, NAVSEA has drafted procedures that employ the criterion of IRR. The Coopers & Lybrand study, "Cost and Benefit Analysis," *Capital Asset Management*, 16 February 1987, also pointed out that the payback criterion has various flaws and that the concept of IRR has many desirable features.

Air Force

AFLC reviews capital-investment proposals from its repair centers under certain circumstances. For equipment funded under the ACP, AFLC reviews projects valued over $300,000; the repair centers are assigned authority to review ACP-funded projects valued at or under $300,000. Once again, all proposals on facilities funded by MILCON are reviewed at headquarters.

Through AFLC Regulation 78-3, *Industrial Resources: Depot Plant Facilities and Equipment Program*, 30 July 1985, the Air Force has institutionalized the application of the NPV concept. It states that the time horizon to calculate NPV is

10 years on equipment, 15 years on semipermanent construction, and 25 years on buildings and warehouses. It also specifies that the discount rate to take account of the time value of money is 10 percent.

The Air Force also has institutionalized its accounting of costs and benefits in the calculation of NPV. Costs include acquisition and installation costs less the disposal value of the replaced equipment or facility. Benefits are calculated from a comparison of the proposed and present investment costs; when costs of civilian personnel, military personnel, maintenance, utilities, or overhead are lower under the proposed investment than that of the present investment, a positive benefit is recorded. The NPV of these benefits and costs is calculated as previously described.

Comments on Air Force Investment Analysis

The Air Force has addressed the uncertainty of its benefits from capital investments in a way that may discriminate against some technological investments. By limiting the benefits of equipment to 10-year time horizons, the questions of obsolescence and risks may be minimized. But, by constraining the time horizon to such short periods, technological investments that typically have longer economic lives and slower benefits would be excluded from consideration (e.g., computer-integrated manufacturing).

Both the Oklahoma City and Warner-Robins Air Logistics Centers are seeking an alternative approach for evaluating their capital-investment projects. Following a review of their depot-maintenance modernization processes, these centers were dissatisfied with the NPV procedures. Apparently, they were having difficulty establishing the priorities (from a depot-wide perspective) of projects proposed by various divisions within the depot. Consequently, an Air Force task force has been organized to help improve its economic analyses for making decisions on capital investments.

PRIVATE SECTOR PRACTICES

In 1984, the Conference Board surveyed 125 companies to determine their decision-making procedures for evaluating capital investments.[1] Thirty percent of the responding companies had an annual capital-expenditure budget below

[1]Davey, P. J. "Managing Capital Investments." Research Bulletin of National Conference Board. No. 165. 1984.

$100 million, 50 percent spent between $100 million and $499 million annually, and 20 percent had capital expenditures at $500 million or higher.

According to the results of the survey, private sector firms generally follow a bottom-up approach to capital budgeting. That is, capital investment proposals originate within operating units, and then are submitted up the corporate ladder for approval. In a few cases, however, corporate management constrains the size of the budget and its content at the outset; within these constraints, the operating divisions then submit ranked lists of desired capital projects.

Strategic planning is an established practice among most corporate respondents, but its influence on resource allocation is mixed. Some companies pay strict attention to 3-to-10-year goals when selecting projects. At others, the relationship between capital investments and long-range strategies is less pronounced. The less-strategic-minded companies tend to focus on the funding of individual projects rather than on the funding of strategies. Proposals that were rejected on strict financial grounds – costs and projected returns – were often not judged on their strategic value toward the future expansion of the company.

The operating divisions generally perform the economic analyses on proposed capital investments. Following a corporate review of such analyses, the operating divisions are then granted authority to commit funds to individual projects. The major appraisal techniques employed by these companies are briefly discussed below.

Internal Rate of Return

The IRR is the technique most frequently used by the respondents to evaluate specific capital investments. In its application, the company computes the discount rate that equates the project's cash inflow to its outflow. This internal discount rate is then compared to an established hurdle rate to help decide on the worth of the project. The hurdle rate generally results from cost-of-capital computations based on the amount and yields of long-term debt, preferred stock, and equity.

Net Present Value

The NPV technique is also used extensively in the private sector, but, among the companies responding to the survey, it is employed only half as much as IRR.

Establishing the discount rate is at the heart of the execution of the NPV concept. Among survey participants, the capital asset pricing model was the most popular approach to costing equity for this purpose. According to that model, the cost of equity is computed by establishing a risk-free rate of return. For example, suppose the return on U.S. Treasury bonds is 8 percent. To that return, one needs to add the product of a risk premium (difference between the return on common stock, 14 percent, and the return on the bonds) and a risk factor, e.g., 0.7 relative risk or beta factor. In this instance, the cost of capital would be 12.2 percent [0.08 + (0.14−0.08)0.7]. Thus, the private sector takes into account not only interest rates but the risks associated with the particular projects.

Payback Period

Of the 125 companies that responded to the Conference Board survey, only 32 (or 25 percent) set a period by which investment costs must be recouped for the approval of capital investments. Such firms believe that the shorter the payback period, the more limited the risk on the returns for the project. Payback periods are often set between 4 and 6 years.

According to four Conference Board surveys conducted over the past 30 years, the payback method is declining in popularity. Apparently, there is widespread recognition that it fails to recognize the time value of cash flows and disregards the revenue streams beyond the recovery point of the investment costs. Also, as shown by the capital asset pricing model, there are alternative approaches for addressing risks in capital investments and they do not carry with them the deficiencies of the payback method.

Evaluation of Technological Investments

Recently, the use of traditional economic analysis techniques – IRR, NPV, and payback period – to evaluate investments in computer-integrated manufacturing

has come under fire. Two recent articles[2,3] have criticized the use of NPV and payback concepts as being biased against the adoption of new technologies. According to these sources, companies that use 15 percent hurdle rates in their calculation of NPVs, or payback periods of 5 years, in effect, dismiss new technologies such as computer-aided design and computer-aided manufacturing. These figures on hurdle rates and payback periods are consistent with the findings of the Conference Board survey on corporations.

Moreover, using the appraisal technique of the IRR, the measurable returns of such projects are not particularly high. For example, the Yamazaki Machinery Company installed an $18 million flexible manufacturing system that had impressive benefits: a reduction in machines from 68 to 18, in employees from 215 to 12, in floor space from 103,000 square feet to 30,000, and in average processing time from 35 days to 1.5 days. After 2 years, total savings came to $6.9 million, and annual labor savings of $1.5 million were foreseen for 20 years. Yet, the IRR of this investment was under 10 percent.

Unmeasured Benefits

In his article,[4] "Must CIM Be Justified by Faith Alone?", Mr. Kaplan argues that traditionally unmeasured benefits need to be more carefully taken into account in the evaluation of computer-integrated manufacturing investments. Under such benefits, he includes greater flexibility, shorter throughput and lead-time, and increased learning of new technology by managers.

These unmeasured benefits can be readily considered in the context of the IRR. For example, a 7 percent IRR is calculated from the following particulars on a capital investment: $12 million cost, annual benefits of $1.035 million, and an economic life of 20 years; the IRR is calculated by Equation C-6 in Appendix C.

If the calculated IRR of 7 percent falls short of the cost of capital – suppose it is 9 percent – this project would normally be rejected. However, the increased flexibility and improved throughput times that would result from this capital

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[2]Kaplan, M. "Must CIM Be Justified by Faith Alone?" *Harvard Business Review.* Mar – Apr 1986.

[3]"The Interface Challenge." *American Machinist.* Special Report 772. Jan 1985.

[4]Kaplan 1986.

investment are not reflected in the calculation of IRR, and these difficult-to-measure benefits might be significant. In fact, they may be the difference between staying in business or being "driven out" by the competition.

By assuming that the IRR is equal to the cost of capital, 9 percent – along with the project's investment cost of $12 million and its economic life of 20 years – we can calculate what the implied difficult-to-measure benefits must be to accept this undertaking. Such a calculation shows that a 9 percent IRR in this case implies that the annual total benefits of the project ought to be $1.185 million. Of that amount, $1.035 million represents the easy-to-measure benefits previously calculated for the 7 percent IRR, and the remainder, $150,000, represents the additional annual benefits that *may be* ascribed to the difficult-to-measure benefits. Thus, if the decision-maker judges that the improved throughput times and flexibility of this capital investment is worth at least $150,000 per year for 20 years, then this project should be accepted on economic grounds.[5] Otherwise, it should be rejected.

SUMMARY OF FINDINGS

DoD's maintenance depots make decisions on capital investments using widely different economic analyses. Table 7-4 summarizes the methodologies and practices currently being used, and they include:

- Labor-saving efficiency of investment
- Payback period – calculated with discounted benefits or with undiscounted benefits
- NPV
- IRR.

Note that the economic analyses employed differ, not only by Military Department, but also among investments for equipment and for facilities within those organizations. It should be reiterated again, however, that DoD guidelines on economic analyses do not preclude such a diversity of methods for evaluating the worth of depot-level capital investments.

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[5]Other difficult-to-measure benefits such as mobilization-required projects or legally mandated health and safety projects could also be judged in this way.

TABLE 7-4

SUMMARY OF ECONOMIC ANALYSES: DEPOT CAPITAL INVESTMENTS

Organization	Type of investment	Economic analysis
Army	Equipment[a] Buildings	Composite of: IRR, NPV, and labor-saving efficiency of investment[b] Composite of: IRR, NPV, and labor-saving efficiency of investment[b]
NAVSEA	Equipment[a] Buildings	7-year payback – undiscounted benefits NPV or payback – discounted benefits
NAVAIR	Equipment[a] Buildings	4-year payback – undiscounted benefits NPV or payback – discounted benefits
Air Force	Equipment[a] Buildings	NPV, payback – undiscounted benefits NPV, payback – undiscounted benefits
Marine Corps	Equipment[a] Buildings	No formal method No formal method

[a] Investments under ACP.

[b] For investments reviewed by DESCOM.

Private Sector

Private-sector firms favor the concept of IRR for evaluating the worth of capital investments. However, NPV is still used extensively in the private sector. The concept of payback – calculated with or without undiscounted benefits – is only occasionally used in the private sector and is rarely defended by economists for making capital-investment decisions. One of the primary findings of the Conference Board survey is that private-sector firms use only one methodology in making capital-investment decisions and that methodology reflects the corporate point of view.

Bias Against Technology

The choice of economic analysis to make capital-investment decisions may influence the rate at which new technology is introduced into an industrial facility. Payback periods of 5 years, or discount rates of 10 percent or more, may result in a rejection of such new technologies as computer-aided design, computer-aided manufacturing, and computer-integrated manufacturing. Such technological investments often have long periods for their benefits to occur, and some of these benefits may not be easily measurable – flexibility, shorter throughput times, and

shorter lead-times. By extension of the IRR concept, these benefits can be considered.

APPENDIX A

DEPOT MAINTENANCE FACILITIES

ARMY

Depots

Facility	Location
Anniston Army Depot	Anniston, Alabama
Corpus Christi Army Depot	Corpus Christi, Texas
Letterkenny Army Depot	Chambersburg, Pennsylvania
Lexington Blue Grass Army Depot[1]	Lexington, Kentucky
New Cumberland Army Depot[2]	New Cumberland, Pennsylvania
Red River Army Depot	Texarkana, Texas
Sacramento Army Depot	Sacramento, California
Seneca Army Depot	Romulus, New York
Sharp Army Depot[2]	Lathrop, California
Sierra Army Depot[2]	Herlong, California
Tobyhanna Army Depot	Tobyhanna, Pennsylvania
Tooele Army Depot	Tooele, Utah

Depot Activity

Facility	Location
Fort Wingate Depot Activity	Gallup, New Mexico
Pueblo Depot Activity	Pueblo, Colorado
Savanna Depot Activity	Savanna, Illinois
Umatilla Depot Activity	Hermiston, Oregon
Navajo Depot Activity	Bellemont, Arizona

Nonindustrially Funded Facility

Facility	Location
Mainz Army Depot[1]	Mainz, Federal Republic of Germany

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[1]Contractor-operated facility.

[2]Supply activity only.

Ober-Ramstadt Depot Activity	Ober-Ramstadt, Federal Republic of Germany
Fischstein Repair Facility	Fischstein, Federal Republic of Germany
Mannheim Repair Facility	Mannheim, Federal Republic of Germany
Pirmasens Repair Facility	Pirmasens, Federal Republic of Germany

NAVY

Naval Aviation Depot (NADEP)

Facility	Location
NADEP Alameda	Alameda, California
NADEP North Island	San Diego, California
NADEP Norfolk	Norfolk, Virginia
NADEP Cherry Point	Cherry Point, North Carolina
NADEP Jacksonville	Jacksonville, Florida
NADEP Pensacola	Pensacola, Florida

Naval Shipyard

Facility	Location
Portsmouth Naval Shipyard	Kittery, Maine
Philadelphia Naval Shipyard	Philadelphia, Pennsylvania
Norfolk Naval Shipyard	Portsmouth, Virginia
Charleston Naval Shipyard	Charleston, South Carolina
Long Beach Naval Shipyard	Long Beach, California
Mare Island Naval Shipyard	Vallejo, California
Puget Sound Naval Shipyard	Bremerton, Washington
Pearl Harbor Naval Shipyard	Pearl Harbor, Hawaii

Naval Ordnance Facility

Facility[3]	Location
NOS Indian Head	Indian Head, Maryland
NOS Louisville	Louisville, Kentucky
NWS Charleston	Charleston, South Carolina
NWS Concord	Concord, California
NWS Earle	Earle, New Jersey
NWS Seal Beach	Seal Beach, California
NWS Yorktown	Yorktown, Virginia

[3]NOS = Naval Ordnance Station; NWS = Naval Weapons Station; NWSC = Naval Weapons Support Center; NWSES = Naval Ship Weapons System Engineering System; NUWES = Naval Undersea Warfare Engineering Station; NAVMAG = Naval Magazine.

NWSC Crane	Crane, Indiana
NWSES Port Hueneme	Port Hueneme, California
NUWES Keyport	Keyport, Washington
NAVMAG Subic Bay	Subic Bay, The Philippines
NAVMAG Guam	Guam, Mariana Islands

Ship Repair Facilities

Guam	Guam, Mariana Islands
Subic Bay	Subic Bay, The Philippines
Yokosuka	Yokosuka, Japan

Public Works Centers

Agana, Guam	Guam, Mariana Islands
Great Lakes	Great Lakes, Illinois
Norfolk	Norfolk, Virginia
Pearl Harbor	Pearl Harbor, Hawaii
San Diego	San Diego, California
San Francisco	San Francisco, California
Subic Bay	Subic Bay, The Philippines
Yokosuka	Yokosuka, Japan

Construction Battalion Centers

Davisville	Davisville, Rhode Island
Gulfport	Gulfport, Mississippi
Port Hueneme	Port Hueneme, California

Other Navy Depot Maintenance Facilities

Strategic Weapons Facility Pacific	Bangor, Washington
Polaris Missile Facility	Charleston, South Carolina
Naval Avionics Center	Indianapolis, Indiana

AIR FORCE

Facility	Location
Ogden Air Logistics Center	Ogden, Utah
Oklahoma City Air Logistics Center	Oklahoma City, Oklahoma
Sacramento Air Logistics Center	Sacramento, California
San Antonio Air Logistics Center	San Antonio, Texas
Warner-Robins Air Logistics Center	Robins, Georgia
Aerospace Guidance and Metrology Center	Newark, Ohio

Aerospace Maintenance and Regeneration Center	Tucson, Arizona
Support Group Europe[4]	Royal Air Force Base, Kemble, United Kingdom
Support Center Pacific[5]	Kadena Air Base, Japan

MARINE CORPS

Facility	Location
Marine Corps Logistics Base Albany	Albany, Georgia
Marine Corps Logistics Base Barstow	Barstow, California

[4]Contractor-operated facility.

[5]Detachment of Ogden Air Logistics Center.

APPENDIX B

HISTORY OF ASSET CAPITALIZATION PROGRAM

INTRODUCTION

The Asset Capitalization Program (ACP) has revolutionized the purchase of new equipment for depot maintenance. In this appendix, we discuss the history of, and rationale for, ACP and its funding by each of the Military Services.

BACKGROUND

Depot maintenance in the DoD is a business that amounts to more than $14 billion a year. To run it as a business, each of the Military Services uses the concept of an industrial fund, which was authorized by Congress in 1949 to emulate private-sector incentives. Under this concept, industrial-fund activities charge their customers for the services provided, and the customers reimburse the industrial fund from their appropriated funds.

In theory, the use of industrial funds should enhance the cost-consciousness of the activities as well as of their customers. Because the customers are charged for the work, they are more aware of its cost; as a result, costs tend to be minimized where possible. Also, because the activities are accountable to their customers and, in some cases, compete for their work, a climate is created to control costs within the activities. Finally, because the industrial funds operate outside the appropriations structure, there is greater managerial flexibility.

Each of the five industrial funds – one for each Military Service and one for Defense Agencies – is made up of activity groups. Figure B-1 shows the anticipated revenues of the depot-maintenance activity groups for FY87.

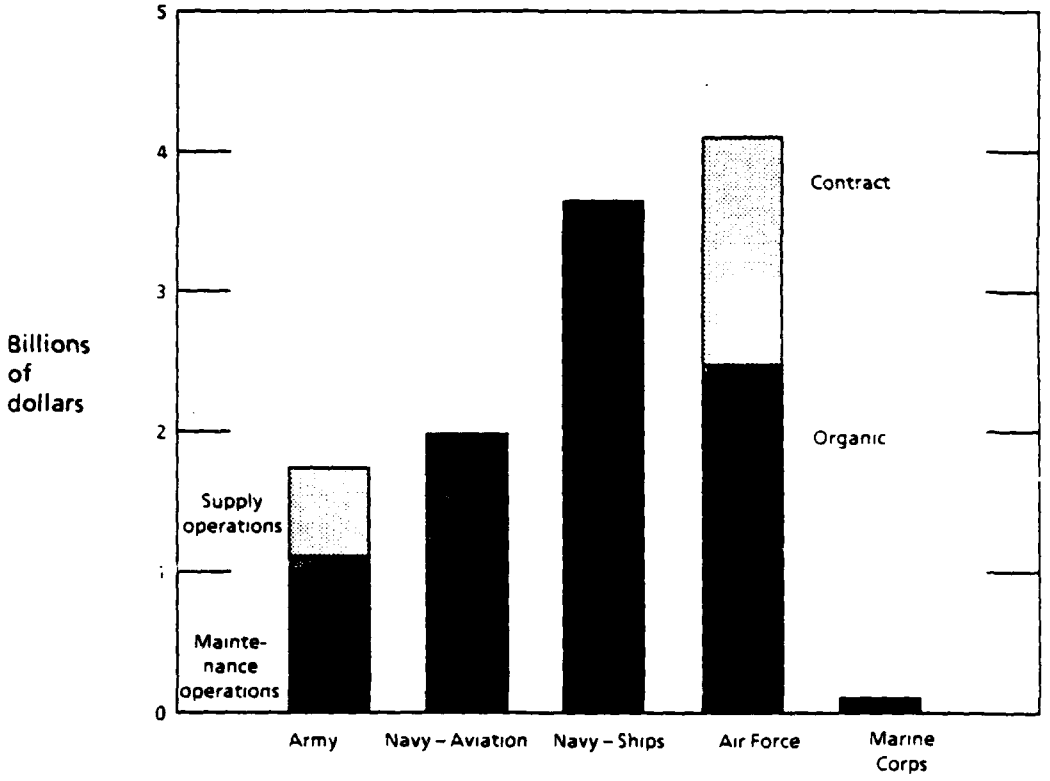

FIG. B-1. ANTICIPATED DEPOT-MAINTENANCE REVENUES, FY87

In the Army, depot maintenance is part of the U.S. Army Depot Systems Command (DESCOM) activity group which also includes supply operations. (The Army depot at Mainz is not included in the industrial fund.) The anticipated FY87 revenues for depot maintenance totals approximately $1.1 billion.

The Navy's depot maintenance activity groups are the Naval Shipyards (NSYs) and the Naval Aviation Depots (NADEPs). In FY87, the NSYs' revenues are expected to total almost $3.7 billion, and the NADEPs' revenues almost $2 billion. The Navy has the largest depot-maintenance program in the DoD.

In the Air Force, the depot-maintenance activity group includes all depot maintenance, both contract and organic. (This is not true of the other Military Services, they only include their organic maintenance depots.) The Air Force's organic depot-maintenance revenues in FY87 are estimated at $2.5 billion.

Depot maintenance is the only activity group in the Marine Corps industrial fund. Revenues for the Marine Corps are anticipated to be $117 million.

There are no depot-maintenance activities in the Defense Agencies' industrial fund.

Appendix A lists the depot-maintenance activities included in each of these activity groups.

Operation of Industrial Funds

As industrial-fund activities, the maintenance depots charge their customers for the goods and services provided. The goal of the funds, and of the activity groups within them, is to break even at the end of each fiscal year, that is, to have revenues equal costs.

The industrial fund rates are established during the budget cycle. For instance, the FY87 rates were established in August 1985, 1 year in advance. This early establishment of rates enables the customers to know how much work they will be able to buy when the budget is executed. It also gives the depot-maintenance activities a better estimate of their eventual workload.

If, at the end of the year, expenses and revenues do not balance out, any gain is refunded to the customers outside the rate structure. If there is a loss, that amount is collected from the customers in what is called a passthrough – again, outside the rate structure. This refund-and-passthrough mechanism prevents fluctuations in the rates, enabling them to reflect anticipated costs rather than year-to-year gains or losses.

THE ASSET CAPITALIZATION PROGRAM

Legislative History

In 1981, the Secretary of Defense proposed the ACP in the President's budget for FY83. Despite opposition from the House Appropriations Committee, the conference committee approved the program, though at half of the proposed funding level. In 1984, Public Law 98-525, "Department of Defense Authorization Act for FY85," placed a floor under the ACP for each of the next 3 years. Revenue for the program was to be some fixed percentage of industrial fund revenues: 3 percent in

FY85, 4 percent in FY86, and 5 percent in FY87. The DoD opposed the use of a fixed percentage, and such floors are no longer in effect.

For FY84, FY85, and FY86, the program was fully funded by Congress. In considering the FY87 budget, Congress [and the Office of the Secretary of Defense (OSD)] expressed concern that the available budget authority was not being used to write contracts quickly enough. The Army and Air Force were directed to refund money from the program to their customers in FY87, and budget authority for the program in the following years was reduced. (Because the rates for FY87 had already been stabilized and could not be changed, Congress ordered a refund – outside the rate structure – using funds collected for the ACP through the rate structure. In later years, the ACP surcharge was reduced, and the reduction was reflected in the rates.)

Definition

The ACP enables industrial fund activities to include depreciation of equipment among the costs recovered in their rate structure. They also are authorized to include in the rate structure a surcharge for the ACP. This surcharge originally was considered a temporary measure that was needed to catch up from the failure to replace obsolete equipment. After the obsolete equipment was replaced, it was thought that the surcharge would no longer be needed and that new equipment could be funded principally from depreciation. The DoD estimated this break-even point to be FY87; the House Surveys and Investigations staff estimated it to be no sooner than FY89 or FY90. The staff also asserted, however, that because of inflation "depreciation charges will never cover replacement costs."

The rationale for the ACP is threefold: (1) the depreciation of assets is an actual cost to the industrial fund, (2) the recovery of depreciation costs is a standard commercial practice, and (3) this recovery makes the industrial fund rates charged to customers more indicative of the true cost of depot maintenance.

A fourth, and perhaps most important, reason for establishing the ACP is that DoD's former practice of buying plant equipment with appropriated funds had not worked. The Military Services have always placed priority on using appropriated funds for the procurement of weapon systems rather than for industrial plant equipment. As a result, much of the plant equipment in the industrial fund facilities became obsolete. The ACP, at least that part resulting from depreciation, is

automatically put in the rate structure, thus bypassing the appropriation process and guaranteeing funding for the equipment.

When compared to funding equipment purchases through the procurement-appropriation channel, the ACP approach generally results in a more responsive process – one that gives the activity manager more flexibility to respond to changes in the operating environment. The Army, however, still requires four or more technical and financial reviews, impeding the pace of its purchases of depot equipment.

The funds must be available within the ACP before they can be obligated for the purchase of new equipment. The DoD originally proposed that ACP funds be required only when outlays for new equipment were anticipated. Congress, however, insisted that the funds be collected before obligation, to prevent large unfinanced obligations. *Funding for the purchases of equipment over $5,000 in value can be carried, unobligated, from one year to the next in the industrial fund.* This contrasts vividly with the current high interest in obligation rates. In fact, in the hope of keeping obligation rates high for the year, it is not unusual for the Military Services to reallocate their funds in midyear from low-obligation-rate activities to high-obligation-rate activities. This obligation-rate emphasis may lead to more expedient, but not necessarily the best investments – especially with the long lead-times of modern-day, high-technology investments.

With specified exceptions, all equipment for depot-maintenance activities is now bought under the ACP. However, equipment peculiar to a new Defense system is paid for by the system's program office, and it is donated to the industrial fund if it is bought at the same time as the prime system. One of the rationales for this outside-ACP purchase is that a contractor would have this kind of equipment provided as Government Furnished Equipment at no charge and that the industrial funds needed a similar mechanism to make their costs comparable to those of the private sector. In the Air Force and Navy, this type of equipment is then depreciated like all other equipment (i.e., by the straight-line method over the projected useful life). In the Army, it is depreciated only if the depot-maintenance activity is expected to replace the equipment when it wears out.

Finally, there is another exception to the purchase of equipment through ACP: mobilization. If the equipment is intended to meet mobilization requirements and not used for peacetime activities, then it cannot be purchased through ACP.

The ACP is also used to fund other specified capital assets, including construction projects under $200,000; alteration, modification, rehabilitation, and installation of capital assets; and management information systems. *Funds for these purposes cannot be carried over unobligated from one fiscal year to the next.*

Originally, ACP was not to fund equipment that expanded the capacity or capability of the depots. For the first year or two, the Military Services asked the activities whether the equipment proposed would expand their capacity or capability. Because no one in OSD or Congress asked for this type of information, the Military Services stopped requesting it. In any event, the distinctions required for such a determination are difficult to draw. If, for instance, a new machine is more productive, does it not expand capacity? Similarly, if the workload is shifting to a new kind of material, does the equipment needed to work with that material constitute additional capability, or is it merely a capability to handle the previous workload, albeit of a different type? It is perhaps because of these problems that interest in this distinction waned.

Method

In constructing a brief history of the funding levels for the ACP, we made extensive use of the Industrial Fund Overview (IFO), prepared by the Assistant Secretary of Defense (Comptroller) for Congress. Data for FY86 and later are taken from the February 1987 IFO; for FY85, from the February 1986 IFO; and for previous years, from either the Military Services or available data. The data presented for FY83 and FY84 are approximate in most cases, principally because the bookkeeping systems for ACP were not yet fully developed, and definitions of what was to be included were still changing. However, the differences in such accounting procedures are marginal, and the general picture of the funding levels for the program is substantially accurate.

The ACP for Army Depot Maintenance

Growth

Figure B-2 shows the cumulative ACP for DESCOM. Although DESCOM provides both depot-maintenance and wholesale resupply, the ACP is not to be used for supply activities. It may, however, be used for joint base-operating and support equipment that is used by both supply and maintenance functions. As of February 1987, by the end of FY87, the Army will have authorized $304 million for the program. Of that amount, outlays of $222 million were anticipated.

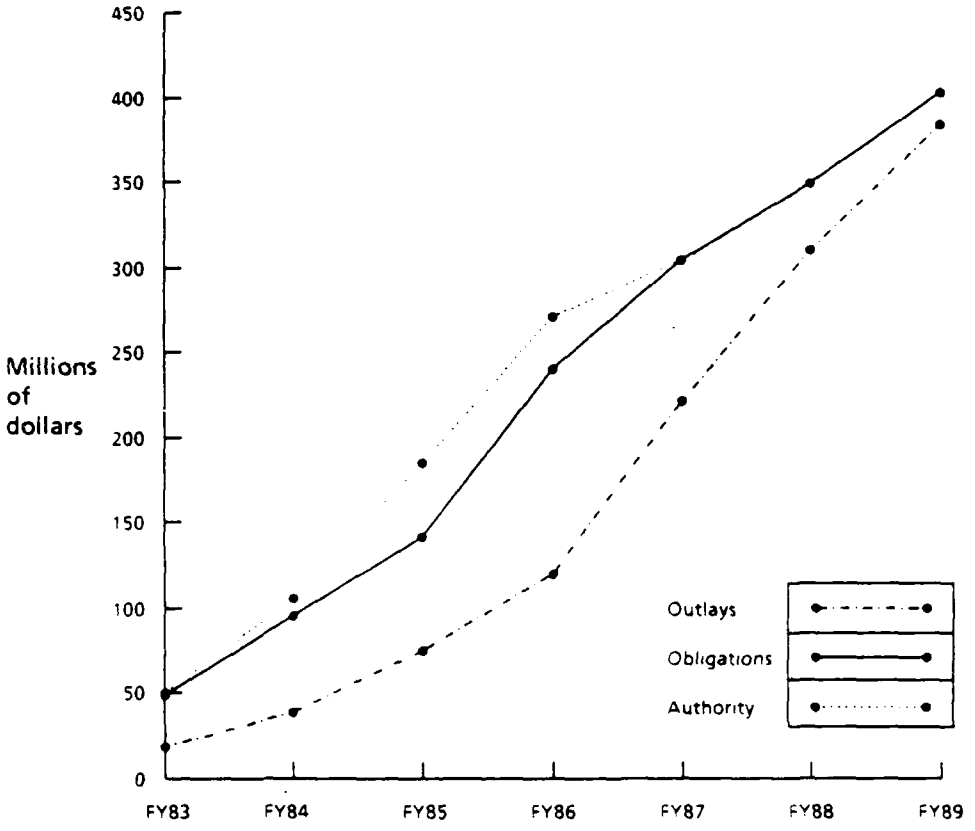

FIG. B-2. CUMULATIVE ACP
(Army - DESCOM)

The ACP program grew substantially from FY83 through FY86, reaching a peak of $85 million in FY86. ACP fell to $34 million in FY87 and it is projected to rise again in both FY88 and FY89. The decrease in FY87 is in response to concerns

by Congress and OSD about the gap between program authority and obligations, particularly noticeable in FY85 and FY86. Outlays rose throughout the period – increasing sharply in FY87 ($102 million) and continuing to increase – but at a lower rate, in the succeeding years.

Financing

Table B-1 shows the makeup of DESCOM's ACP for depreciation and surcharge from FY86 through FY89. The bottom line in the table (e.) shows the difference between the sum of depreciation and surcharge (c.) and the total new program amount (d.). The differences are minor. Note that the surcharge (a.) was eliminated in FY87, but then reappears at a low level in FY88 and FY89. The contribution of depreciation shows slow growth.

TABLE B-1

MAKEUP OF DESCOM ACP
(Millions of dollars)

Category	FY86	FY87	FY88	FY89
a. Surcharge	$ 49.5	$ 0.0	$ 9.6	$ 10.4
b. Depreciation	29.9	36.3	34.4	43.2
c. Surcharge plus depreciation	79.4	36.3	44.0	53.6
d. Total, new program	85.1	33.9	44.0	53.6
e. Difference (c. – d.)	$ -5.7	$ 2.4	$ 0.0	$ 0.0

Relation to Revenues

Table B-2 shows the depot-maintenance portion of DESCOM revenues, total new program authority, and the latter as a percentage of the former. The percentage drops to 3.04 percent in FY87 and does not exceed 5 percent until FY89.

TABLE B-2

ACP AS A PERCENTAGE OF DESCOM REVENUE

(Dollars in millions)

Category	FY86	FY87	FY88	FY89
Depot maintenance revenues	$ 1,183.2	$ 1,116.9	$ 1,072.3	$ 1,048.8
New program	$ 85.1	$ 33.9	$ 44.0	$ 53.6
Program/revenue	7.19%	3.04%	4.10%	5.11%

The ACP for Navy Depot Maintenance

Naval Aviation Depots

Growth. Figure B-3 shows the cumulative ACP for the NADEPs. For FY87, the Navy will have authorized $414 million for the program. Outlays will reach $283 million at that time. As shown in Table B-3, the program (d.) grew to a peak of $125 million in FY87, decreasing to $93 million in FY88. The program is projected to continue at approximately $100 million per year for the next few years.

Financing. Table B-3 also shows the makeup of new program amounts on depreciation and surcharge for FY86 through FY89. The negative FY86 difference in line e. is surprising in that accelerated billing – which increased revenues above previous estimates – should have had a similar effect on ACP revenues. The excess of revenues over program amounts in FY87 may reflect an increase in engine workload.

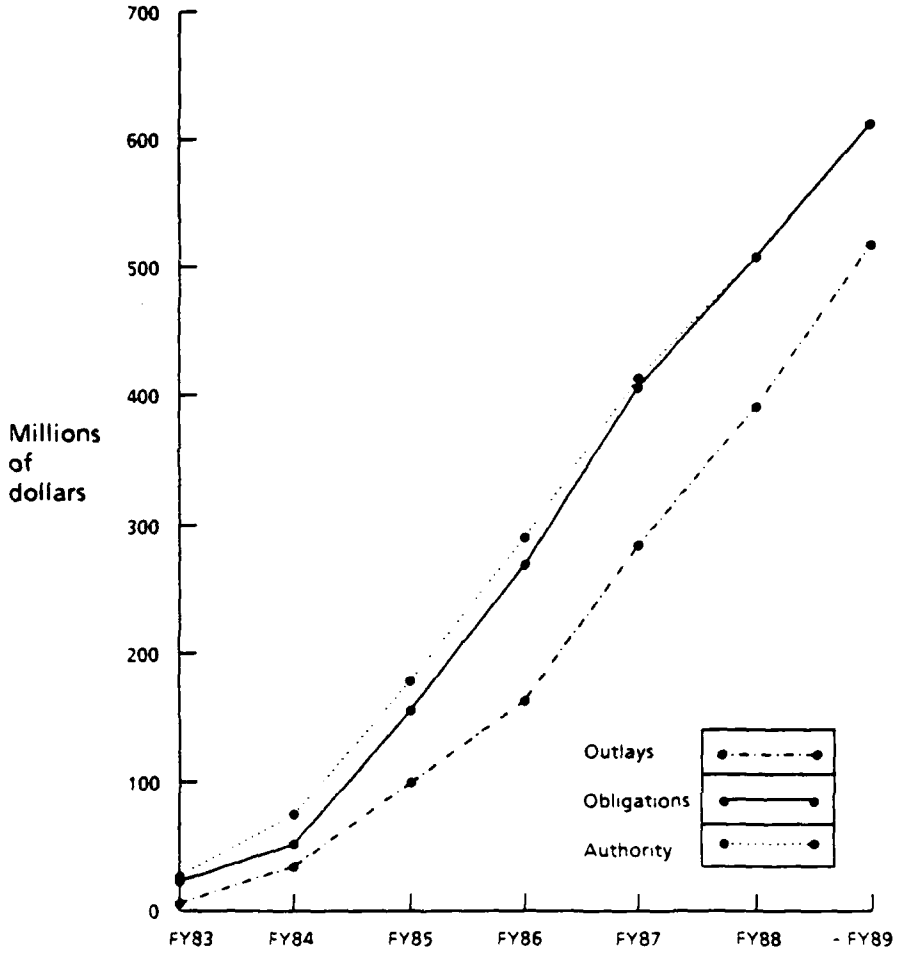

FIG. B-3. CUMULATIVE ACP
(NADEP Facilities)

Relation to Revenues. Table B-4 shows the NADEPs' revenues, the total new ACP authority, and the latter as a percentage of the former. This percentage stays well above 5 percent in all 4 years.

Naval Shipyards

Growth. Figure B-4 shows the cumulative ACP for the NSYs. For FY87, the Navy will have authorized a total of $692 million. Of this amount, outlays will have

TABLE B-3

NADEP ACP MAKEUP

(Millions of dollars)

Category	FY86	FY87	FY88	FY89
a. Surcharge	$ 57.2	$ 87.9	$ 40.3	$ 43.8
b. Depreciation	41.2	50.5	53.2	60.3
c. Surcharge plus depreciation	98.4	138.4	93.5	104.1
d. Total, new program	110.7	125.1	93.5	104.2
e. Difference (c. – d.)	$ -12.3	$ 13.3	$ 0.0	$ -0.1

TABLE B-4

ACP AS A PERCENTAGE OF NADEP REVENUE

(Dollars in millions)

Category	FY86	FY87	FY88	FY89
Revenues	$ 1,867.3	$ 1,997.0	$ 1,780.7	$ 1,852.1
New program	$ 110.7	$ 125.1	$ 93.5	$ 104.2
Program/revenue	5.93%	6.26%	5.25%	5.63%

reached a level of $441 million, the largest amount for any depot-maintenance activity group.

Financing. The Navy's ACP for its shipyards grew quickly in the first few years, reaching a peak of $200 million in FY87. It is projected to continue being funded at approximately $170 million for the next 2 fiscal years.

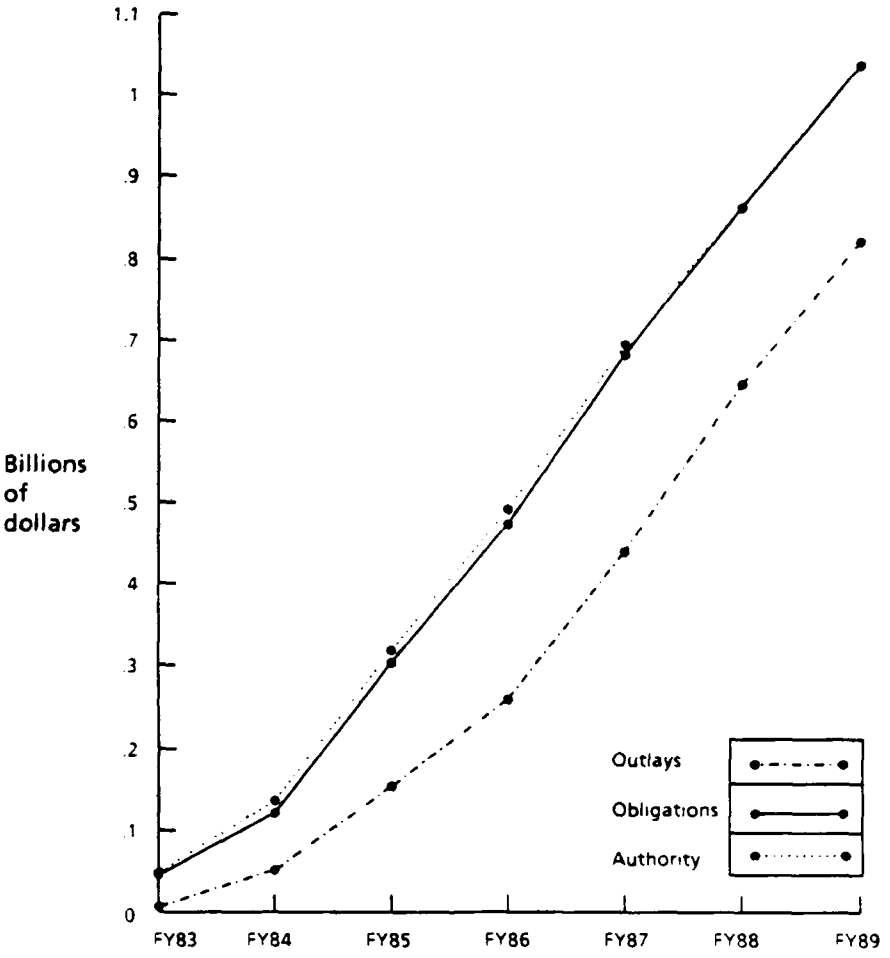

FIG. B-4. CUMULATIVE ACP
(Naval Shipyards)

Table B-5 shows total new program amounts for the NSYs and their makeup by depreciation and surcharge for FY86 through FY89. The excess revenues (e.) in FY87 are thought to be a direct result of Congressional action.

Relation to Revenues. Table B-6 shows the NSY revenues, total new ACP authority, and the latter as a percentage of the former. This percentage rises above 5 percent in only one of the 4 years.

TABLE B-5

MAKEUP OF NSY ACP

(Millions of dollars)

Category	FY86	FY87	FY88	FY89
a. Surcharge	$ 120.7	$ 147	$ 99.3	$ 96.2
b. Depreciation	61.2	71.1	69.3	79.4
c. Surcharge plus depreciation	181.9	218.1	168.6	175.6
d. Total, new program	174.4	200.2	168.6	175.6
e. Difference (c. – d.)	$ 7.5	$ 17.9	$ 0.0	$ 0.0

TABLE B-6

ACP AS A PERCENTAGE OF NSY REVENUE

(Dollars in millions)

Category	FY86	FY87	FY88	FY89
Revenues	$ 3,782.0	$ 3,660.1	$ 3,756.5	$ 3,877.4
New program	$ 174.4	$ 200.2	$ 168.6	$ 175.6
Program/revenue	4.61%	5.47%	4.49%	4.53%

The ACP for Air Force Depot Maintenance

Growth

Figure B-5 shows the cumulative ACP for the Air Force Depot Maintenance Industrial Fund (DMIF). For FY87, the Air Force will have authorized $608 million for its ACP, with outlays totaling more than $400 million.

As shown in Table B-7, the program grew rapidly in its first few years (d.), reaching a peak of $181 million in FY86. The present size of the program, approximately $100 million a year, is projected to increase over the next few years.

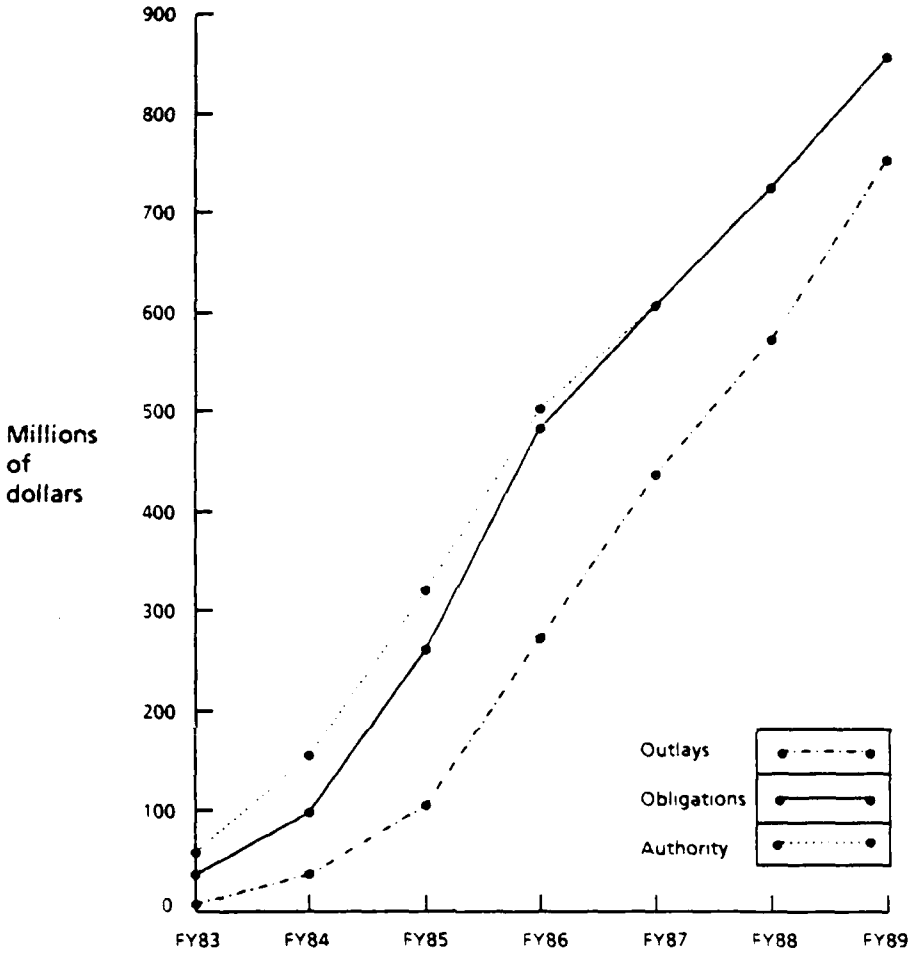

FIG. B-5. CUMULATIVE ACP

(Air Force)

The gap between authority and obligations (most noticeable in FY84 and FY85) – which caused a reduction in funding in FY87 – is projected to close in the future.

Financing

Table B-7 shows total new program amounts for the Air Force's DMIF and their makeup by depreciation and surcharge for FY86 through FY89. The difference

between the sum of depreciation and surcharge and the total new program amount (e.) in FY87 can be attributed to a Congressionally mandated refund.

In FY86, the difference shown in line e. was attributable, in part, to an underestimate of $14 million in the revenues accruing from the ACP surcharge. This difference is surprising in that the level of work performed by the Air Force's DMIF in total was less than expected, which, *ceteris paribus*, would lead one to expect lower ACP revenues.

It is noteworthy that by FY89 the Air Force's ACP is financed almost wholly by depreciation charges.

TABLE B-7

AIR FORCE DMIF ACP MAKEUP

(Millions of dollars)

Category	FY86	FY87	FY88	FY89
a. Surcharge	$ 122.2	$ 35.4	$ 13.2	$ 8.3
b. Depreciation	85.9	88.1	104.7	122.5
c. Surcharge plus depreciation	208.1	123.5	117.9	130.8
d. Total, new program	181.1	105.8	117.9	130.8
e. Difference (c. – d.)	$ 27.0	$ 17.7	$ 0.0	$ 0.0

Relation to Revenues

Table B-8 shows the Air Force's DMIF organic revenues, total new program authority, and the latter as a percentage of the former. After reaching a peak of 7.23 percent in FY86, the percentage drops to a low of 4.25 percent in FY87 – principally in response to the Congressional cut – and then steadily increases in the following years.

TABLE B-8

ACP AS A PERCENTAGE OF DMIF REVENUE

(Dollars in millions)

Category	FY86	FY87	FY88	FY89
Revenues	$ 2,503.6	$ 2,491.0	$ 2,419.6	$ 2,420.8
New program	$ 181.1	$ 105.8	$ 117.9	$ 130.8
Program/revenue	7.23%	4.25%	4.87%	5.40%

The ACP for Marine Corps Depot Maintenance

Growth

Figure B-6 shows the cumulative ACP for the Marine Corps Industrial Fund (MCIF). For FY87, the Marine Corps will have authorized almost $23 million for the program, with outlays totaling more than $15 million. The program is projected to continue at about $7 million a year.

Financing

Table B-9 shows total new program amounts for the MCIF and their makeup by depreciation and surcharge for FY86 through FY89. As the table shows, depreciation is projected to account for an increasing portion of the Marine Corps' ACP.

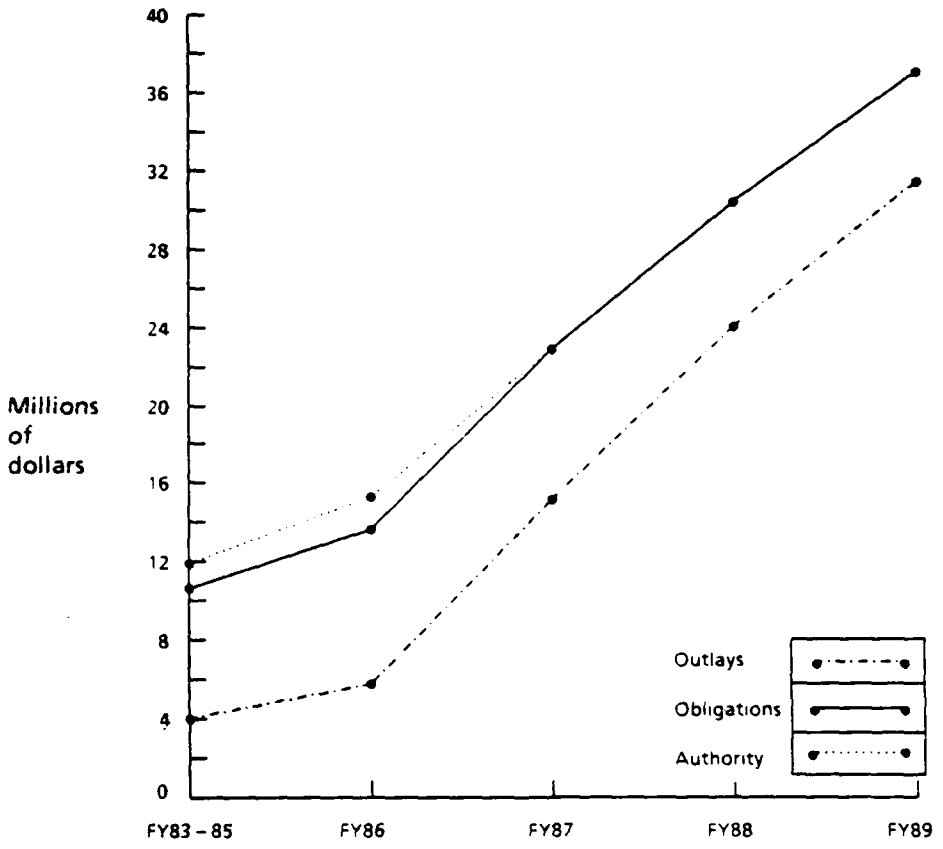

FIG. B-6. CUMULATIVE ACP
(Marine Corps Industrial Fund)

Relation to Revenues

Table B-10 shows the MCIF organic revenues, total new program authority, and the latter as a percentage of the former. Rising from a low of 3.4 percent in FY86, the percentage stays well above 5 percent in the years that follow.

The Depot-Maintenance ACP Program in Total

Looking at the depot-maintenance ACP from a DoD-wide perspective, several questions surface immediately: Is the underlying rationale for the program still sound? Is the program large enough to modernize depot equipment? Is the money divided appropriately among the Military Services? Are the trends in funding

TABLE B-9

MAKEUP OF MCIF ACP

(Millions of dollars)

Category	FY86	FY87	FY88	FY89
a. Surcharge	$ 0.0	$ 7.1	$ 5.4	$ 4.2
b. Depreciation	1.8	2.0	2.2	2.4
c. Surcharge plus depreciation	1.8	9.1	7.6	6.6
d. Total, new program	3.4	7 5	7 6	6.6
e. Difference (c. – d.)	$-1 6	$ 1.6	$ 0.0	$ 0.0

TABLE B-10

ACP AS A PERCENTAGE OF MCIF REVENUE

(Dollars in millions)

Category	FY86	FY87	FY88	FY89
Revenues	$ 99.7	$ 117.2	$ 117.9	$ 120.3
New program	$ 3.4	$ 7.5	$ 7.6	$ 6.6
Program/revenue	3.41%	6.40%	6.45%	5.49%

healthy or unhealthy? And, finally, are the dollars being invested in the "right" equipment? This last question is beyond the scope of this appendix. We can, however, respond to the other questions using the data presented.

Rationale

The underlying rationale for the program is still sound. Depreciation of equipment is a cost of doing repair work, like any other, and it should be paid by the customers. Using the rate structure to fund the ACP is therefore correct. In addition, it is good management practice to make the process for acquiring new

equipment responsive to operations and to place responsibility for identifying the requirements for equipment at that level.

Program Size and Its Allocation

What is the proper size for the program? Is the program appropriately divided? These are very difficult questions. One commonly used measure to judge the pace of replacing capital assets is the capital-replacement program as a percentage of total revenues. If the 5 percent figure suggested in the Congressional hearings at the inception of the ACP and in the accompanying Surveys and Investigations report is reasonable, the NADEPs are performing well, the Air Force and Marine Corps are doing fairly well, the NSYs are not performing well, and the Army is not doing well but recovering.

However, using the 5 percent figure implies that there is, or should be, a similar level of capital intensity for all these disparate organizations. It also assumes that all the activities start with the same assets in terms of their state of technical sophistication and age. Such assumptions may not be met.

We can examine the differences in the Military Services' assets to some extent by looking at the portion of their programs that are financed through depreciation rather than through surcharge. If the FY88 program for each Military Service is constructed to be 5 percent of actual revenues for that year and its depreciation charges are estimated to be received in FY88 at the anticipated level, then we can compute that Military Service's "acceleration" of depreciation; all other things being equal, greater depreciation rates imply a more modern stock of assets. This computation is shown in Table B-11, as are the percentages of the program represented by depreciation and surcharge.

Implications. According to Table B-11, the Air Force would finance 87 percent of the nominal 5 percent program from depreciation of current assets, the Army and the NADEPs would finance about 60 percent, and the NSYs and the Marine Corps would finance only 37 percent.

This suggests that, by FY88, the Air Force will have installed a more modern base of equipment in its depots than will the Navy, Army, or Marine Corps. It further implies that the NSYs and Marine Corps in particular, along with the NADEPs and Army, should be trying to improve their equipment, by enacting

TABLE B-11

DEPRECIATION AS A PERCENTAGE OF A NOMINAL ACP

(Dollars in millions)

Activity group	Projected FY88 revenue	Nominal 5% program	Projected FY88 depreciation		Required FY88 surcharge	
Army	$1,072 3	$ 53.6	$ 34.4	64%	$ 19.2	36%
NADEPs	1,780.7	89.0	53.2	60	35.8	40
NSYs	3,756.5	187.8	69.3	37	118.5	63
Air Force	2,419.6	121.0	104.7	87	16.3	13
Marine Corps	$ 117.9	$ 5.9	$ 2.2	37%	$ 3.7	63%

programs that exceed the 5 percent level. In fact, however, the shipyards will fall short of 5 percent (4.49 percent), as will the Army (4.10 percent), and the Air Force (4.87 percent). The NADEPs (5.25 percent) and the Marine Corps (6.45 percent) will exceed that threshold.

Trends

In looking at the trends in the ACP for depot maintenance, we conclude that the program is steady or at least recovering from a one-time setback in FY87. It is also at a level that can be effectively utilized; i.e., the obligation rate in all the Military Services is projected to be high. The trend in depreciation as a percentage of total revenue is also encouraging. As shown in Table B-12, the percentage of total revenue represented by depreciation is increasing in each of the Military Services.

Although many of the ACP trends are encouraging, one important question still remains: Is the absolute value of the program adequate? Before this question can be answered, however, we would need to quantify the other sources of funding for depot-maintenance equipment, and then construct an appropriate yardstick for gauging how much is enough.

TABLE B-12

DEPRECIATION AS A PERCENTAGE OF REVENUE

Activity Group	FY86	FY87	FY88	FY89
Army	2.53%	3.25%	3.21%	4.12%
NADEPs	2.21	2.53	2.99	3.26
NSYs	1.62	1.94	1.84	2.05
Air Force	3.43	3.54	4.33	5.06
Marine Corps	1.81%	1.71%	1.87%	2.00%

APPENDIX C

METHODS FOR EVALUATING CAPITAL INVESTMENTS

ECONOMIC CONCEPTS

An economist is typically concerned with investment-evaluating principles and procedures that will direct funds away from less productive capital projects toward those that promise greater returns. When following such principles or procedures, the economist is seeking the highest stream of returns on the capital invested. Three of the most common methods for evaluating capital investments are payback period (PP), net present value (NPV), and internal rate of return (IRR).

Payback Period

The PP, also called the payout period or amortization method, is a criterion by which the worth of a capital investment is sometimes judged. The PP of an investment is the number of years required for its accumulated earnings or savings to equal its cost. Both the costs and the benefits are measured in constant dollars.

An example: Suppose that Table C-1 displays the benefits expected from Project A, a piece of equipment that costs $2.2 million to acquire and install. These benefits – savings on labor, utilities, and other costs – are derived from the replacement of an older piece of equipment. Because the accumulated benefits equal the $2.2 million cost after 5 years, the PP for this investment is 5 years.

Shortcomings

The PP criterion has two basic shortcomings. First, as is shown in Table C-1, this piece of equipment yields returns not just for the 5-year payback period but for 12 full years. Yet, *the additional 7 years of benefits beyond the payback point* are not considered.

Ignoring the full benefit streams of investments can lead to nonsensical decisions. For example, consider an alternative piece of equipment that also has an investment cost of $2.2 million and a 5-year payback. Suppose this piece of equipment does not have any benefits beyond the 5th year. By the PP criterion, the

TABLE C-1

CAPITAL INVESTMENT YIELDS

Year-end	Savings ($ thousands)	Cumulated savings ($ thousands)
1	310	310
2	335	645
3	440	1,085
4	515	1,600
5	600	2,200
6	625	2,825
7	650	3,475
8	500	3,975
9	400	4,375
10	300	4,675
11	200	4,875
12	100	4,975

5-year and 12-year machines would have the same PP, and the decision-maker should be indifferent between them. On the contrary, the 12-year machine is clearly the better investment.

The second major shortcoming with the PP concept is that it ignores the time value of money. For example, suppose two alternative capital investments cost $2.21 million each and each has a 5-year payback, but the timing of their benefits is inverse to one another. As shown in Table C-2, Project B has returns greater than Project A in the first 2 years, the same return in the 3rd year, and lower returns in the 4th and 5th years. Most decision-makers would not be indifferent between these two alternatives, preferring Project B, with its earlier benefits, over Project A. Yet, by applying the payback concept, the two investments are rated as equally beneficial because their PPs are the same – 5 years.

The PP concept is rarely defended in the economic literature because it lays down a terminal date for the consideration of benefits to avoid the problem of estimating longer term benefits. Limiting the timeframe of analysis is a crude solution to address the uncertainty of longer term benefits. Also, by restricting the

TABLE C-2

ALTERNATIVE BENEFIT STREAMS

Year-end	Benefits ($ thousands)	
	Project A	Project B
1	310	600
2	345	515
3	440	440
4	515	345
5	600	310
Total	2,210	2,210

timeframe of the benefit stream, the PP method tends to bias capital investments toward the short term and away from the long term. As a result, technological investments that are associated with long-term benefit streams and slower payback tend to be rejected if they are evaluated by the PP method.

Net Present Value

The criterion of NPV determines whether the stream of benefits from a capital investment – when expressed in a present, lump-sum equivalent – is greater or less than the cost of that investment. To convert the stream of benefits into its present, lump-sum equivalent, the "exchange rate" between a dollar today and its value in the future needs to be established. As an illustration, suppose that the best opportunity open to a decision-maker promises an 8 percent rate of return. Then, for this decision-maker, $1.00 in hand today would be worth $1.08 in year 1, $1.17 in year 2, and $1.26 in year 3.

The time value of money needs to be factored into the evaluation of the benefits and costs of a project because their time patterns almost always differ. Some of the various formulas for making such calculations are given in the last section of this appendix.

The best way to explain the NPV criterion is by an example. Suppose that a $6 million investment in a new facility is being considered. With the particulars in Table C-3 – annual savings of $800,000 for 50 years, at an 8 percent discount rate – the present discounted value of this project's savings is *$10.6 million*. With NPV, the decision rule for acceptance or rejection of a particular capital investment is straightforward: If the present, lump-sum benefit is greater than the investment cost, then the project is accepted; on the other hand, if the benefit falls short of the investment cost, the project is rejected. In this instance, the NPV is a positive $4.6 million – $10.6 million in benefits minus $6 million in cost – so the project would be accepted.

TABLE C-3

INVESTMENT PARTICULARS

Cost	=	$6 million
Annual savings	=	$800,000
Discount rate	=	8 percent
Expected life	=	50 years

Conceptually, the NPV avoids the principal shortcomings of the PP concept. It considers the full, unrestricted timeframe in which benefits can be expected, whether 10 years, 50 years, or 150 years, and it takes into account the time value of money by converting the stream of benefits into a lump-sum equivalent value at the present time.

Shortcomings

Although NPV is an improvement over PP, it is not without shortcomings. First, it is unclear what discount rate should be used to calculate the present value of the benefit stream from the investment. The most appropriate discount rate is the decision-maker's rate of return on alternative projects, which may differ from market interest rates.

For example, suppose a decision-maker needs to choose between two projects. If the returns from both investments are, say 12 percent, the relevant loss resulting

from the postponement of one of the investments is not the market rate of interest – 9 percent, for example – but the return on the most promising capital investment, which may be 12 percent. In this instance, the 12 percent rate is referred to as the opportunity cost of the decision-maker's funds.

A second difficulty with deciding upon a discount rate occurs when inflation is built into the benefit stream. In theory, the discount factor should incorporate inflation. However, an 8 percent nominal interest rate has a far different meaning to the decision-maker in an inflationary environment of 6 percent than in an inflationary environment of 3 percent. Can we say that the inflation-inclusive interest rate is 8 percent in both of these cases? The answer is not clear. It depends upon how much of the inflation rate already is embodied in the market interest rate. Because the inflation rate may be only partially embodied in the market interest rate, reflecting inflation in the interest rate is not straightforward.

Third, a capital-investment decision needs to take into account the differences in the risks for receiving the benefits. One way to address risk is to increase the discount factor to reflect such differences. For example, suppose the risk-free rate of interest is 8 percent, measured by the yield on U.S. Treasury bonds. This rate might be increased by 1 percent to reflect a mildly risky project – to 9 percent – or it might be increased by 3 percent to reflect a speculative capital investment – to 11 percent. In this way, uncertainty or risk can be addressed directly, but the risk factors are determined subjectively.

Finally, selection of the appropriate discount rate is even further complicated when governmental capital investments are considered. As explained in Chapter 7, the Office of Management and Budget has used the concept of the average rate of return in the private economy – including an average allowance for risk – to represent the Government's discount rate for the purchase of assets. The argument for such a discount rate is that the average rate of return in the private sector reflects what could be earned if resources were not diverted to the public sector. However, V. L. Broussalian has argued that even the average rate of return in the private sector may not truly reflect the opportunity cost of governmental, non-marketable investments.[1]

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[1]Center for Naval Analyses Research Contribution No. 15. *The Evaluation of Non-Marketable Investments*. Broussalian, V. L. 30 June 1965.

In summary, the concept of NPV has a potential operational difficulty in the establishment of the appropriate discount rate. The discount rate may not simply be the market interest rate or the return on private investments. The return to a decision-maker may be affected by the funds available for capital investments, by inflation, and by risk, and these factors can be incorporated only with difficulty, if at all. As a result, it is even difficult to rank projects with this procedure, let alone select the "best" alternative.

Internal Rate of Return

The IRR is a measure used to evaluate the internal profitability of a specific investment project. The IRR makes this evaluation by equating the stream of benefits from the capital investment to its investment cost. A project-specific internal discount rate is imputed by such a process, which may be neither the market interest rate nor the discount rate developed for applying the NPV concept.

As an example, we return to the case in Table C-3 – a $6 million capital investment with savings of $800,000 per year for 50 years. The IRR for this project is 15 percent. That is, by Equation C-6 in this appendix, the benefits of $800,000 per year for 50 years, compounded at 15 percent per year, are equivalent to the $6 million investment cost.

The decision rule for making capital investments with the IRR concept is as follows: If the IRR is greater than the relevant cost of capital to the decision-maker, the project should be accepted; if the IRR is less than the relevant cost of capital, the project should be rejected. (The cost of capital is often referred to as the "hurdle rate.") In this example, as long as the cost of capital is less than 15 percent, then the project should be accepted.

The IRR is particularly useful when investment funds are constrained because the market discount rate no longer reflects the opportunity cost of funds. In this instance, the projects with the highest IRRs should be selected until the funds are exhausted.

Theoretical Problem. From a theoretical perspective, the IRR calculations may yield misleading results under unusual conditions. These conditions are if either the

returns to the project alternate between positive and negative for several periods, or if the projects being compared have markedly different time horizons.[2]

The condition of alternating positive and negative returns is not very likely for the equipment and facilities in the maintenance depots. Typically, those capital investments have negative returns in the early years, followed by positive returns for the remaining life of the asset. Such a single alternating of positive and negative returns will not yield misleading results for IRR calculations. In any case, to guard against multiple or nonsensical IRR results, various procedures have been adopted; for example, see Myers, M., et al., *Discounted Cash Flow Model for the Industrial Modernization Incentives Program*, LMI Report RE301-4, November 1985.

On the condition of markedly different time horizons for alternative capital projects, DoD Instruction 7041.3, *Economic Analysis and Program Evaluation for Resource Management*, 18 October 1972 specifies that the time horizons for projects be adjusted so that they are equal. This can be done by shortening the time horizon for the longer project to match that of the shorter time-horizon project. The resultant terminal value of the longer term project then needs to be entered into the IRR calculation.

Summary. The IRR is a concept that works in most applications. Its principle benefit is that it yields a "hard" number for the rate of return that can be used to rank projects. This is especially important when funds are restricted and market discount rates are no longer applicable. The IRR concept also provides the capability for considering difficult-to-measure benefits when the estimated cost of capital might be slightly higher than the IRR.

FORMULAS FOR ECONOMIC CALCULATIONS

The basic formulas for making economic calculations are straightforward.

We begin by presenting the arithmetic principles that must be employed to compare present and future receipts and outlays. Suppose K dollars are invested for 1 year at the rate of interest i, compounded annually; then, at the end of the first

[2]For a general discussion of these exceptional cases, see Baumol, W. J., *Economic Theory and Operations Analysis*. New Jersey: Prentice Hall. Fourth Edition. 1977: pp. 604 – 610.

year, the return would be iK. The total dollars received at that time would be that return plus the original investment: $K + iK = K(1+i)$ dollars.

With this in mind, we can then take account of the time value of money. Suppose we call the initial investment K_0 (K dollars at our initial date, year 0) and K_1 the sum accumulated after 1 year of return on that investment. Mathematically, the one period *accumulated value* is given by:

$$K_1 = K_0(1+i) \qquad \text{[Eq. C-1]}$$

If we then solve for K_0 in Equation C-1, we obtain the basic present-value relationship:

$$K_0 = \frac{K_1}{(1+i)} \qquad \text{[Eq. C-2]}$$

The factor i is called the discount rate, and the result of taking a future return (K_1) and bringing it to the present (K_0) is called the present discounted value.

PRESENT-VALUE FORMULA

By extension, the present value of a *stream* of returns can be discounted to the present:

$$V_0 = K_0 + K_1\left(\frac{1}{1+i}\right) + K_2\left(\frac{1}{1+i}\right)^2 + \ldots + K_n\left(\frac{1}{1+i}\right)^n \qquad \text{[Eq. C-3]}$$

Equation C-3 can be used to re-express a project's stream of time-differentiated benefits to its present value. (Costs of the project can also be so discounted. However, investment costs are often largely, if not entirely, incurred before benefits begin to accrue – at time 0 – and, thus, such costs here are already in present-value terms.)

However, the returns on capital investments may be constant from year to year (holding inflation constant). In that event, Equation C-3 can be substantially simplified to calculate a present value of a benefit stream. From Equation C-3, a

constant benefit stream means that $K_0 = K_1 = K_2 = \ldots = K_n = K$; with the constant-K benefit stream,

$$V_0 = K\left(1 + \frac{1}{1+i} + \left(\frac{1}{1+i}\right)^2 + \ldots + \left(\frac{1}{1+i}\right)^n\right). \qquad \text{[Eq. C-4]}$$

By invoking the sum of a geometric series and simplifying, Equation C-4 becomes:

$$V_0 = \frac{K(1+i)}{i}\left(1 - \left(\frac{1}{1+i}\right)^{n+1}\right). \qquad \text{[Eq. C-5]}$$

Equation C-5 is applicable for computing the present value of a capital investment when its returns are constant from year to year, and it is easier and less costly to compute than Equation C-3. On the other hand, Equation C-3 is applicable when the investment's returns differ from one year to another.

IRR CALCULATIONS

In calculating IRR, the costs (V_0) and returns (K_i) are given and one only needs to solve for the implied discount rate that equates these two streams. The implied discount rate is the IRR.

The IRR formula can be derived from Equation C-5 if the returns are constant from period to period. Solving Equation C-5 for the implied discount rate (i), yields:

$$\frac{V_0}{K} = \left(\frac{1+i}{i}\right)\left(1 - \left(\frac{1}{1+i}\right)^{n+1}\right). \qquad \text{[Eq. C-6]}$$

The implied discount rate, i, is derived iteratively by applying rates on the right-hand side of Equation C-6 until that yields the value V_0/K on the left-hand side of that equation.

Similarly, the IRR formula can be derived from Equation C-3 if the returns *vary* from period to period. To express the results in a similar form to Equation C-6, we divide both sides of Equation C-3 by the sum of the returns ($\Sigma_i K_i$), which yields:

$$\frac{V_0}{\Sigma Ki} = \frac{K_0}{\Sigma Ki} + \frac{K_1}{\Sigma Ki}\left(\frac{1}{1+i}\right) + \ldots + \frac{K_n}{\Sigma Ki}\left(\frac{1}{1+i}\right)^n. \qquad \text{[Eq. C-7]}$$

Note that the right-hand side of Equation C-7 has a series of terms that involve the implied discount rate for each period and the relative returns for that period. Equation C-7 is also solved iteratively by applying rates on the right-hand side of that equation until it yields the value ($V_o/\Sigma K_i$) on the left side of that equation.

APPENDIX D

DRAFT POLICY MEMORANDUM: ECONOMIC ANALYSIS FOR DEPOT-MAINTENANCE MODERNIZATION

PURPOSE AND OBJECTIVES

This Policy Memorandum establishes a uniform economic analysis of capital investments for the modernization of DoD maintenance depots. It provides guidelines on the use of the criterion of internal rate of return (IRR) for this purpose.

This Policy Memorandum is based upon DoD Instruction 7041.3, *Economic Analysis and Program Evaluation for Resource Management*, 18 October 1972. It builds on that Instruction and makes it directly applicable to the evaluation of proposed equipment and facilities for DoD maintenance depots.

APPLICABILITY AND SCOPE

The provisions of this Policy Memorandum apply to the Military Departments.

This Policy Memorandum covers projects concerned with the modernization of the maintenance depots. Specifically, this includes capital investments in equipment, facilities, and computer hardware and software. These capital investments may lead to a reduction in costs and/or to the improved performance of existing missions. Decisions on capital investments to establish a new mission or capability are not addressed in this Policy Memorandum.

Capital investments are proposed for various reasons. Some for traditional economic reasons – e.g., to replace old, worn-out equipment with state-of-the-art equipment to reduce costs. Others are proposed to retain a basic capability to perform an assigned mission, to keep operations timely, or to comply with Occupational Safety and Health or Environmental Protection Regulations. Regardless of the impetus for proposing the replacement capital investment, each of these purchases falls under the purview of this Policy Memorandum.

This Policy Memorandum does not cover decisions on buying versus leasing capital assets. The Office of Management and Budget (OMB) Circular No. A-104, *Evaluating Leases of Capital Assets*, revised 1 June 1986, prescribes a special procedure for the buy-or-lease decision.

BACKGROUND

A coherent strategy for modernizing maintenance depots is difficult to carry out because of the different economic analyses used by the Military Departments. The Military Departments routinely employ six unrelated economic analyses for their proposed investments under the Asset Capitalization Program (ACP) and military construction (MILCON) program. These different economic yardsticks make it difficult to rank buildings and equipment on the basis of economic value.

Also, with these different economic criteria, additional time and effort are required to perform these analyses and to obtain the necessary approvals. These diverse procedures impede the process for modernizing the depots.

For these reasons, there is a need to establish a single criterion for the economic analysis of all capital investments in the maintenance depots.

After assessing the various methods used in the depots and in the private sector, we have selected the criterion of IRR as the basis to rank capital investments for the maintenance depots. The IRR equates the project's stream of costs to its stream of benefits with a derived internal discount rate. Corporations employ this criterion more than any other technique to rank proposed capital investments. The depots have microcomputers and software packages to easily implement the IRR criterion.

ECONOMIC ANALYSIS

a. Introduction

The DoD needs a systematic approach for choosing how to employ scarce resources to modernize its maintenance depots. For a given modernization strategy, there are various capital investments that may be consistent with the objectives of

that strategy. The determination of which particular capital investments are most efficient and effective is accomplished by:

1. Systematically identifying various equipment and facilities to replace the existing asset. The existing and the alternative asset should produce the same, required outputs of repairs and maintenance. Where the outputs differ, adjustments need to be made or the comparisons will not be sound;

2. Identifying differences in operating costs and performances between the existing and the "best" alternative asset to estimate the relative savings of the capital replacement; and

3. Highlighting the sensitivity of the decision to the values of the key variables and assumptions on which the decision is based – including anticipated workload, mobilization plans, and the depot's strategy on technology.

An economic analysis is required when there is a choice or tradeoff between two or more options to meet an ongoing mission. One option is to maintain the status quo – i.e., to keep an existing piece of equipment in the depot. The other is some proposed capital investment to replace the existing asset.

A project justified on the basis of a military necessity will not be exempt from the requirement to perform an economic analysis. For an ongoing military-mandated objective, the current way of accomplishing that objective needs to be compared against its alternatives.

b. Costs

As stated in DoD Instruction 7041.3, all resources necessary to achieve the objective should be incorporated into the economic analysis. In making estimates of these resources, special care should be taken to work with categories of costs that are mutually exclusive of one another – thereby avoiding the problem of double counting.

Also, other basic principles should be kept in mind in estimating costs. First, when feasible, life-cycle cost estimates should be developed for the capital investment. Those estimates should include all anticipated expenditures that are

directly or indirectly associated with a capital project, and these costs should be listed year-by-year. Second, costs which already have been incurred at the time an analysis is made – so-called sunk costs – should not enter into the comparison of alternative capital investments.

The cost of making a capital investment in the maintenance depots should be broken down into the following categories:

1. Research and Development;

2. Investment Costs: Startup or onetime costs include:

   (a) The cost of rehabilitation, modification, or addition of land, buildings, machinery and equipment.

   (b) The cost of rehabilitation; modification; or other capital items such as furnishings and fittings required to put the project on a "ready-to-use" basis.

   (c) The cost of rearranging the plant and tooling associated with the project.

   (d) The cost of freight, foundations, and installations required by the project.

   (e) The value of nonrecurring services received from others – both internal and external to the DoD. Although difficult to measure, such services should be estimated if at all possible.

   (f) Working capital: the amount of liquid funds and current assets on hand or on order. Include here inventories of consumable items and resources required for the project.

   (g) The imputed value of existing assets to be employed on the project. When an asset is transferred from its normal use to work on a project, the value of that asset should be imputed to the new project if a cash payment is lost to the Government as a result. Similarly if the sale of an asset is deferred to work on a project, the value of that asset should be imputed to this project. The valuation of the asset may be imputed to the

project's investment cost based on market price, scrap value, or alternative-use value.

(h) The terminal value of existing assets should be treated as a reduction to the setup cost of the proposed project. The terminal value may be determined by sale price, scrap value, or value in alternative use.

3. Recurring (Operating) Costs: These costs include personnel, material consumed in use, operating, overhead, the annual cost of support services, and any other multiperiod cost. Difference in these costs are used to evaluate the relative "worth" of alternative assets. Specifically:

(a) The cost of civilian personnel services involved directly in the work to be performed. This cost reflects gross pay as well as the Government's contributions to civilian retirement, disability health, life and health insurance. This cost is on an annual basis, not just direct labor hours that is applied.

(b) The cost of military personnel services involved directly in the work performed. Again, complete military personnel cost should be included as in (a).

(c) The aggregation of personnel cost not covered in (a) and (b): travel, per diem, moving expenses, personnel training, and similar costs.

(d) The cost to the Government of supplies and materials used in providing a product or service. Include in this figure the cost of scrap materials and utilities that are directly related to the function as well as the cost of handling, storage, and protection of property.

(e) The cost of maintenance and repair to buildings, structures, grounds, and equipment that are utilized in producing goods and services. Include only those maintenance and repair expenses directly attributable to the project under analysis.

Capital improvements should not be included, but reflected under investment costs.

(f) The cost of overhead that will change as a result of the undertaking of the project. This includes services for accounting, personnel, legal, local procurement, medicine, storage, issue of supplies, police, and fire.

c. Benefits

The alternative asset and the existing asset it would replace both should produce the same required repairs and maintenance; adjustments need to be made when these benefits differ. With benefits equal, differences in operating costs are used to determine the relative worth of the assets.

Various savings in operating costs may result from the replacement of a piece of equipment or of a facility in the DoD maintenance depots and they can be directly measured. The sources of these savings are covered in the categories of recurring or operating costs defined above. For example, a piece of equipment that is selected to replace an existing asset might reap substantial yearly savings in terms of: direct labor in the repair operation, indirect labor, maintenance, power, and tooling.

However, other benefits also may be important but are not so easily measured. For example, certain equipment or processes may offer reduced throughput times, shortened lead-times, and increased flexibility, but these factors are difficult to measure in terms of dollar-value savings. Also, some facilities may be proposed for the improvement of employee safety and health – also difficult to gauge. Finally, equipment that may be proposed to meet current military-dictated missions also presents a difficulty of quantification.

Such important benefits need to be evaluated. A procedure to assess these difficult-to-measure benefits is prescribed in Section g.

d. Economic Life

The economic life of the alternative asset governs the time period to be covered by an economic analysis. The following definitions should be followed for this purpose:

1. The operating cost of the proposed and the existing capital investments need to cover the same period. For analysis, the operating cost of the proposed and the existing asset should *begin* in the same year – after the proposed projects can be set up. If the operating cost of the alternative *ends* in different years: adopt the same end point for both based on the asset with the shorter life (usually the current asset) and consider the residual value of the other asset (usually the proposed asset) that results from truncating its benefits at the adopted end point. Residual values may be determined by the sale price, scrap value, or value in an alternative use.

2. Economic life should be based upon the period of usage that the asset can produce the required product or service dependably. Depreciation guidelines established by the Internal Revenue Service or other regulatory bodies should not be used for this purpose if better data are available. Also, neither technological life – which can be considerably shorter than economic life – nor physical life – which can be considerably longer than economic life – is the appropriate timeframe to evaluate capital investments for the maintenance depots.

e. Treatment of Inflation

All estimates of setup costs and operational savings for the planning period should be made in terms of the purchasing power of the dollar at the time of the decision. That is, these costs and savings should not reflect any forecasted changes in the general price level over the planning period.

f. Formula for Analysis

The IRR equates the setup cost of a proposed purchase of equipment or a facility to the savings in operating costs that would result from the substitution of

that proposed capital asset for the existing asset operating in the depot. The basic formula for IRR is as follows:

$$NRC_0 + \ldots + NRC_k (D)^k = S_{k+1} (D)^{k+1} + \ldots + (S_{k+n} + RV)(D)^{k+n} \qquad \text{[Eq. D-1]}$$

where:

NRC = nonrecurring costs to setup project (known, usually incurred in the first period, subscript k = 0, for equipment, but in multiple periods for buildings, k = 1 or k > 1)

D = 1/1 + i or the discount factor; i = IRR that equates savings to costs – the solution sought for Equation D-1

S = savings in operating costs resulting from proposed project [estimated: beginning in $(k+1)^{st}$ period after proposed project is set up to replace existing asset; positive values, often varying from period to period]

n = length of time in which current asset can produce required product or economic life of proposed asset, whichever is shorter (usually current asset's remaining productive years would be shorter)

RV = residual value of proposed project at period k + n (arises when current asset cannot produce required product for as long as new, proposed asset).

For the depots, a unique IRR can be expected from Equation D-1. Mathematically, this follows from two properties: capital investment in the depots have setup costs exceeding savings in the early years and savings exceeding those costs, if any, in the remaining years; and any differences in the economic lives of the alternatives can be adjusted to equality as indicated above. Otherwise, multiple or nonsensical IRR values may occur and a special algorithm would need to be added to Equation D-1 to select the relevant IRR. No such complications are involved here.

Computationally, the IRR for Equation D-1 can only be found by iteratively selecting alternative values of i until Equation D-1 is satisfied. To avoid manually performing such an iterative procedure, microcomputers and

spreadsheet-software packages can be used for this purpose. Many spreadsheet packages have formulas already programmed to calculate IRRs.

g. Ranking and Hurdle Rates

By solving Equation D-1 for each proposed project, a unique IRR for each project results. Everything else being equal, the higher the IRR of a project the higher its priority for implementation.

The ranking of projects should follow two principles. First, all projects should be included in a single ranking regardless of their sizes and sources of funds. That is, MILCON, ACP, and other projects of all sizes should be commingled, ranked, and compared on the basis of their IRRs. Second, projects should be included in the ranking that have IRRs starting at 5 percent rates, not at the Government's higher hurdle rate; as discussed below, the 5 percent rate would permit consideration of important but difficult-to-measure benefits as well as accommodate a possible lower Government hurdle rate.

The Government has a hurdle or cutoff rate for the selection of capital investments. This hurdle rate is subject to change, and, in fact, the OMB is reviewing it at this time. According to current DoD and OMB Instructions, the hurdle rate for the purchase of capital assets by DoD maintenance depots is 10 percent – representing the rate of return on private investment, with average risk and with the factoring out of inflation but before taxes. Everything else being equal, all projects with IRRs above the prevailing hurdle rate should be approved, while all projects with IRRs below the cutoff rate should be rejected; if funds are restricted, however, only some of the projects above the hurdle rate (those with the highest IRRs) should be undertaken.

Moreover, the IRRs that have been calculated thus far do not take into account various difficult-to-measure benefits that may be important for some projects. For example, there may be substantial savings from increased flexibility in repairs with a new piece of equipment replacing an old piece of equipment. For a project that has an IRR somewhat below the prevailing hurdle rate, considerations such as increased flexibility may make the difference between acceptance or rejection of that project.

Consider the following case. Suppose a project has a calculated IRR that is below the OMB hurdle rate of 10 percent. That calculated IRR, say 8 percent, was derived with a given setup cost for the new piece of equipment – NRC terms in Equation D-1 – and with a stream of operating-cost savings – S terms in Equation D-1. Now, suppose that the new piece of equipment is thought to offer substantial benefits in terms of increased flexibility in repairs. The procedure below has been developed to evaluate such a situation.

In this procedure, ask the question: Does consideration of flexibility in repairing with the proposed project raise the total savings of that project to justify the 10 percent IRR, the hurdle rate? To answer that question, calculate the savings in Equation D-1 that are implied by a 10 percent IRR and compare them to the savings associated with the calculated 8 percent IRR (keeping the startup costs the same). To accomplish this:

(1) Raise the previously estimated pattern of savings – S used to calculate the 8 percent IRR in Equation D-1 – by that uniform percentage increase (j percent) which yields a 10 percent value for i, the hurdle rate. Thus, each 10 percent-implied saving would have the form: S(1 + j percent). Working with a software package on a microcomputer, various percentage increases in savings may have to be tried to reach the 10 percent rate for i in the formula.

(2) Compare the higher potential stream of savings implied by the 10 percent hurdle rate against the stream of savings calculated with the 8 percent IRR. Can the dollar-value difference between the 10 percent-implied savings and the 8 percent-related savings be legitimately ascribed to greater flexibility in repairing? If this increment in dollar savings can be explained convincingly by the increase in flexibility, the rate of return of that project may be raised to the level of the hurdle rate; if not, the original, lower IRR should remain for that project.

In any case, the Military Departments should show two project rankings: one for the directly measurable benefits alone, and the other for the difficult-to-measure savings as well as the directly measurable benefits. In this way, the

subjective analyses used to evaluate difficult-to-measure benefits can be reviewed apart from the more traditional analysis.

h. Sensitivity Analysis

There are two basic factors that need to be estimated to calculate the IRR criterion. First, the economic life of the piece of equipment or facility needs to be projected. Second, the operating costs (in today's dollars) needs to be estimated for each alternative over this extended timeframe. Each of these estimates is subject to error and, therefore, ranges for these factors may need to be considered to make these calculations properly.

IMPLEMENTATION

To implement this Policy Memorandum, the Military Departments should write a detailed handbook. The handbook should work through the microcomputer-spreadsheet software that the Military Department has chosen to make the IRR calculations. Working with the software, examples should be included in the handbook to cover situations that involve purely traditional benefits – differences in operating costs as defined – as well as the important difficult-to-measure benefits that are more and more characteristic of modern-day capital investments.

The Military Departments have 60 days to implement this Policy Memorandum.