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TECHNICAL REPORT TR 78-9-72

COST-BENEFIT ANALYSIS APPLIED TO THE PROGRAM OBJECTIVES MEMORANDUM (POM)

DECISIONS AND DESIGNS INCORPORATED

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November 1978

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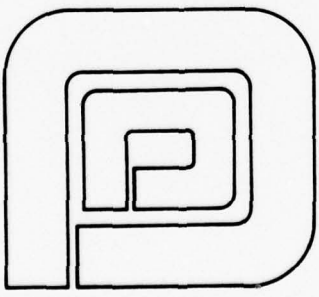
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9 TECHNICAL REPORT (TR-78-9-72)

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**COST-BENEFIT ANALYSIS
APPLIED TO THE PROGRAM OBJECTIVES
MEMORANDUM (POM)**

by
10 Dennis M. Buede and Janice E. Ragland

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SUMMARY

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This report describes the approach that Decisions and Designs, Incorporated (DDI), has developed with funding from ARPA, the Marine Corps, and the Army to improve the Program Objectives Memorandum (POM). The POM is a five-year plan of expenditures submitted annually by each armed service within the Department of Defense (DoD). By drawing upon the techniques of applied psychology and decision analysis, a new method has been developed to quantitatively assess the benefits of military programs, both within and across their various functional and mission areas. These quantitated benefits can be used with cost estimates to design a POM that provides maximum long-term efficiency (benefits per dollar) within the constraints of short-term (five-year) affordability. The report describes both the method of quantitating benefits and the method of using these benefits with cost estimates to produce an improved POM. It is the quantitation of benefits that makes this possible. So long as they remain intangible and unmeasured, an efficient POM cannot be designed.

Though focused on DoD, the report has general applicability to all long-term planning and budgeting, whether within Government or outside it. The report should be of interest to senior managers with general responsibility for overall organizational planning and budgeting, and to the staff analysts who support these functions.

Section 1.0 describes the POM setting, the typical procedure for POM development, and the general problems with these procedures. These problems stem from the organizational structure of proponency in a DoD service, the multi-year cost and benefit complications of the POM programs, the

continous readjustment of the POM during its development, and the task of defending the POM's validity when it reaches higher levels of management.

Section 2.0 provides (1) a brief, general description of decision analysis and (2) details of the methods of quantitating benefits and prioritizing POM programs on the basis of long-term efficiency. This prioritization is accomplished by assessing the relative (life-cycle) costs and benefits of the programs and ranking the most cost-beneficial (that is, the highest benefit-per-dollar) program first, the second most cost-beneficial program second, and so on. The only change in the cost analysis typically done during the POM process is that now the relative life-cycle cost implications of each program must be identified. The relative benefits of the POM programs are assessed by first eliciting the relative benefits from each proponent for his programs. This iterative procedure must be completed carefully to ensure that the analysis is valid. Once each proponent is satisfied with the implications of the benefit scale covering his programs, he is asked to write a rationale defending the scale.

Next, a cross-sponsor group is convened to develop a benefit scale for selected programs from each proponent's list of programs. First, this group is educated by the proponents about the programs to be considered. They then go through the iterative benefit elicitation for these programs until any inconsistencies between their judgments and the judgments of the proponents have been resolved. The entire benefit elicitation procedure motivates the proponents to be candid about their programs and to provide their true judgments when considering the benefit scale for their programs. This explicit procedure for prioritizing many programs is also more efficient than typical implicit ones.

Section 3.0 describes the five applications of this cost-benefit methodology to the preparation of Marine Corps and Army POMs. The first application was to the 1979-1983 POM (POM-79) for the Marine Corps in Fiscal Year 1977. Applications completed in Fiscal Year 1978 included the Marine Corps' POM-80, the prioritization of the Marine Corps Research, Development and Studies (RD&S) programs for the Navy's POM-80, the Army's POM-80, and the prioritization of Program Analysis and Resource Review (PARR) issues for the Army's POM-80.

The application of the cost-benefit methodology to zero-base budgeting (ZBB) is described in Section 4.0. The prioritization of decision packages by a hierarchy of managers is the purpose of ZBB. This is exactly the purpose of the cost-benefit procedure. The advantages of the cost-benefit procedure over the typical ZBB applications are that (1) the relative costs and benefits of the decision packages are made explicit by each manager with a brief rationale for all to see; (2) the prioritization by upper-level managers is simplified because the benefit scales and rationale are expanded, not lost (destroyed) at each successive level; and (3) the avoidance of "piggy-backing" can be assured when decision packages are combined at the various levels of the hierarchy.

Finally, Section 5.0 contains conclusions and recommendations. The explicit, systematic cost-benefit analysis of POM program prioritization has been well received in both the Marine Corps and Army and successfully used during their POM preparations.

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COST-BENEFIT ANALYSIS APPLIED TO THE
PROGRAM OBJECTIVES MEMORANDUM (POM)

1.0 INTRODUCTION

1.1 The Setting

The process of preparing a Program Objectives Memorandum (POM) is a complex lesson in the allocation of resources. The POM is the five-year plan by which each of the armed services within the Department of Defense proposes to allocate its resources (people and dollars). This five-year plan begins two years in the future (for example, the POM for 1980 through 1984 was completed in May 1978).

The primary players in this POM process for an individual service are a group of proponents who span the functional needs of the particular organization. Thus, the range of issues under consideration is quite diverse. (See Table 1-1 for the list of Army proponents.) Each proponent is responsible for developing programs within a specified area of the organization and brings to this decision-making arena a list of such programs, ordered from most important to least important, for which he seeks funding. These programs are incremental and mission-oriented in nature. They are incremental because there is a core of activity that is so essential to the organization as to be inviolate, and these programs are typically increments of portions of this core. (The purpose of zero-base budgeting is to uncover sections of this core that are not really inviolate.) The functional categorization of the proponents provides the mission-orientation of these programs which makes them generally independent of each other in terms of cost and value to the organization.

DCSOPS	Deputy Chief of Staff for Operations
DCSRDA	Deputy Chief of Staff for Research, Development, and Acquisition
DCSPER	Deputy Chief of Staff for Personnel
OCAR	Office of the Chief of Army Reserve
NGB	National Guard Bureau
AAD	Army Automation Directorate
DCSLOG	Deputy Chief of Staff for Logistics
OCE	Office of the Chief of Engineers
PA&ED	Program Analysis and Evaluation Directorate
OTSG	Office of the Surgeon General

Table 1-1
ARMY PROPONENTS

The organization is set up along functional (proponency) lines; thus, there is a great deal of competition among proponents for the scarce resources. Since the proponent's task is to be expert in the needs of his particular functional area, he is accustomed to thinking about the organization only in terms of his functional area. The POM process is the focal point for determining the organization's overall needs by evaluating the relative needs of each of the functional areas. (There is an analogue of the POM process for any government or business organization. In fact, the structure of an organization by proponents is the rule rather than the exception, and what is said here can be interpreted for any such organizations.)

In performing this evaluation, the goals and responsibilities of the organization are the primary focus. In general, these goals and responsibilities have been developed around functional/mission categories to guide the proponents in formulating their programs. This functional/mission categorization, therefore, does not provide much help in choosing among programs sponsored by different proponents. Since the goals and responsibilities primarily establish functional areas, there is no explicit relationship between these goals and a particular proponent's programs. Consequently, the priorities a proponent assigns to his programs are in the final sense based on his judgment of the relative merits of each program. This judgmental assessment encompasses not only the organization's goals and responsibilities, but also the many outside influences (political, economic, and so forth) that bear on the final priorities.

The final result of the POM effort is the selection, from among the programs proposed, of a subset of programs to be funded within the resource constraints of the organization. This subset of programs is projected over a five-year period because nearly all of them have future resource implications

to the organization. Although many of these implications extend well beyond the five-year POM period, only the five-year fiscal constraints are made explicit. These fiscal constraints, while explicit, are not known with certainty, and so are defined in terms of levels or bands (Figure 1-1).

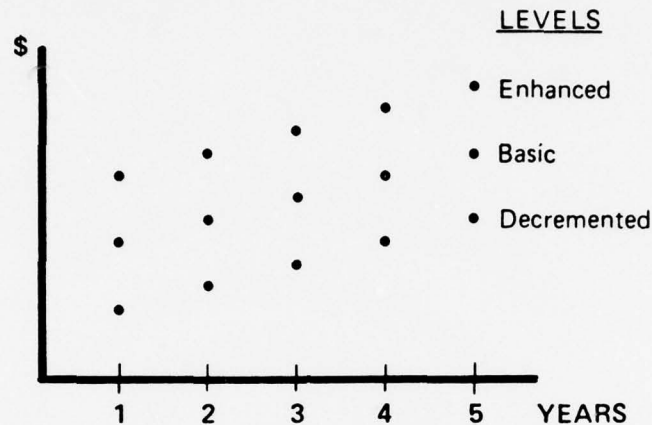


Figure 1-1

LEVELS OF FISCAL CONSTRAINTS

The expected fiscal constraint for each of the five years is designated the basic level; the enhanced and decremented (or minimum) levels are defined above and below the basic level, respectively. These levels are determined outside the organization by the Office of the Secretary of Defense (OSD). The actual fiscal constraint typically lies between the decremented and basic levels.

Just as there is uncertainty in the fiscal constraint, the cost profile over time associated with each proponent's program is uncertain and complicated to calculate. The appropriate profile is the incremental cost that results if this program is funded. The uncertainty is present whenever the future is involved. The complexity arises because future (inflated) dollars must be specified, and the programs involve various types of outlays, classified as appropriations. The reason the various appropriations such as manpower, operations and maintenance (O&M), and procurement, are involved is

that each has a different spend-out rate. That is, \$100 programmed for 1980 in each of the three appropriations mentioned above will be spent over different periods of time. Most of the \$100 for O&M and manpower will be spent in 1980, and it will all be spent by 1982 or 1983. However, the appropriation for procurement will be spent over many years, perhaps seven or eight. Tables of escalation rates are published at the beginning of each POM cycle by OSD to assist the services in translating dollars between fiscal years. These escalation rates enable each proponent, when his programs are formulated, to estimate the expected cost profiles of his programs. The ability to move dollars between fiscal years is also important near the end of the POM cycle: At that time, the five-year fiscal constraints must be met exactly, and this is often accomplished by moving money within programs from one fiscal year to another.

Once the POM is finalized and sent to OSD for review, the services' major tasks are to defend and to modify it. Two types of critics review the plan, generalists and specialists. The generalists must understand the overall picture and review the POM for general imbalances that might be present across major categories. The specialists critique the plans within specific categories. In both instances, certain critics focus on functional or mission categories, and others focus on appropriation categories. Each organization must defend its POM when these critics find faults with it; clearly, the quality of these defenses is a major determinant of the organization's final budget. In every case, the backbone of both criticism and defense is judgment, augmented by whatever empirical data can be found. A systematic procedure for prioritizing POM programs that makes the judgment process explicit would vastly improve their justification.

Finally, the first year of the POM (as amended during the OSD review process) must be turned into a budget. This is currently being done in accordance with ZBB by developing decision units and decision packages within each appropriation category. In order to maintain the functional integrity of the POM programs, it is important that the ZBB prioritization of decision packages coincide with the POM prioritization of programs. As an example, if all but one of a functional set of decision packages is funded, that functional POM program will be severely impaired if not rendered inexecutable. The budget constraint for this first POM year is never known with certainty until the very end, so there are many adjustments being made up to time of the final submission. Just as it is important that the POM and budget prioritizations be coordinated initially, it is equally important that these adjustment decisions be made with complete knowledge concerning their effect upon the functional POM programs.

There are two principle ways in which these adjustments can be made to meet a changing fiscal constraint. (Actually these adjustments are made many times during the POM and budget preparations.) The decision makers can cut (or add) functional programs or they can spread the decrease (or increase) across many functional programs. When the decrease is spread across many programs, no decision is made to decrease the scope of these programs and therefore more money will be required in future years to cover the work that has been delayed. Therefore, spreading the cut across many programs is one of the causes of what has come to be known as the bow wave effect (see Figure 1-2). Because this percentage cut across many programs is used repeatedly during a single POM-budget cycle and repeated yearly, the bow wave of future resources needed to cover delays in programs becomes quite pronounced.

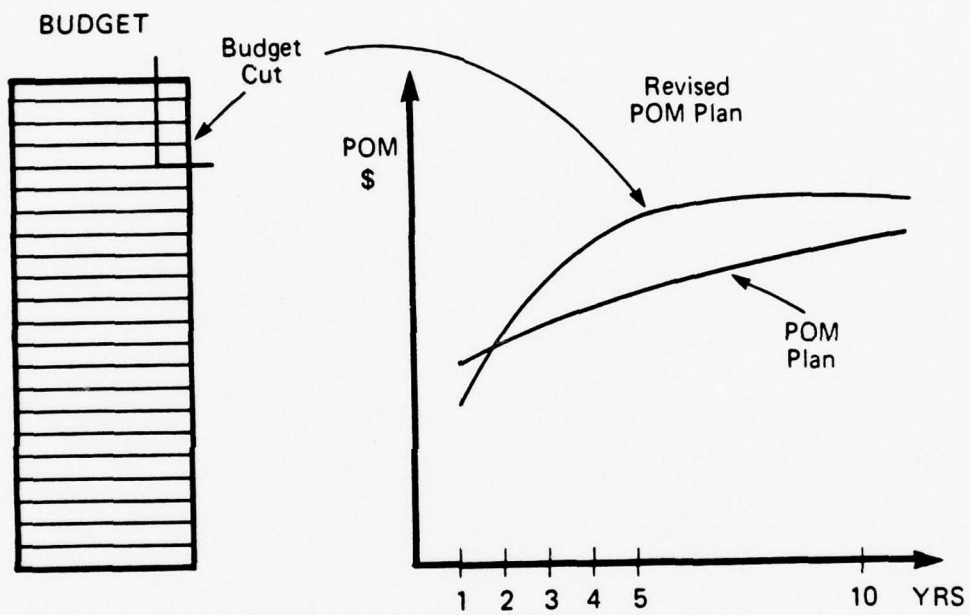


Figure 1-2
BOW WAVE

1.2 Typical Modus Operandi

The procedure for handling a decision-making problem like the one described here varies little among the organizations with which we have worked. Typically, the decision-maker of the organization appoints a committee comprised of the proponents to put together a recommendation for him. The chairman of this committee is, however, usually independent of the proponents. (In some organizations, there is a group whose job it is to interface with the proponents, but the proponents have the final authority.) The major variation across organizations seems to be the degree to which the decision maker modifies the recommendation proposed by this committee.

Each proponent composes a list of programs that he feels need to be funded in order for his part of the organization to function properly. Before the meeting for establishing overall program priorities, each proponent prioritizes his own programs from most important or beneficial to least beneficial. This prioritization can be done either mentally or explicitly, but the result is usually the same: the most cost-beneficial programs are spread throughout the list. The process that the committee then uses to mesh the prioritized lists of all the proponents in order to recommend which programs should be funded resembles the "smoke-filled room" much more than any systematic, logical procedure for which one might hope.

Naturally, during this process the proponents compete; they push their own programs, argue against the programs of others, and trade favors. This competition gives rise to certain games the proponents play. One such game has been termed the "gold watch" routine. In this case, the proponent substitutes a vital program from the core (the inviolate necessities of the organization) for an item he wants very

badly but has little chance of getting funded. The questionable program is now firmly embedded in the core, and the critical program is on the table for consideration. In most organizations, the exact make-up of the core is somewhat obscure to everyone because little effort is expended to examine its composition. Thus, this game is difficult to uncover, but also somewhat difficult to play since the core is not that easy to change. Zero-base budgeting is the best, although costly, means of curtailing this practice.

Providing fuzzy information about one's programs is another strategy that enables a proponent to make his programs seem better than they are. In this way, the other proponents are kept from finding reasons to refute the utility of the programs in question. However, it is clearly difficult for a committee to make sound recommendations when they must work with fuzzy information.

Finally, it is quite common for a proponent to pad his lists with programs that should never be seriously considered by the organization. With these programs the proponent produces points with which to make concessions during the bargaining sessions.

Several conclusions can be drawn about the characteristics of a recommendation produced by using this typical *modus operandi*. First, the programs that are recommended for funding will be either the most beneficial to the proponents or will have considerable outside interest. (It is very common for the proponent to argue, "If we don't put it in, . . . will make us take something else out and put it in.")

Second, the costs of the programs are used primarily to gauge the closeness of any recommended set of programs to the fiscal constraints specified. For this reason, funding

implications of individual programs beyond the period of interest (five years for the POM) are considered of little importance and too difficult to estimate anyway. Also, the programs funded are typically the most expensive ones.

This modus operandi does not permit the generation of any systematic defense for its output. Rather, the proponents are relied upon to explain why their programs have been included. This competitive bargaining among proponents may sharpen the defense of their programs, but not nearly so much as it might if the proponents were not rewarded for keeping their programs fuzzy. In the end, however, the organization will never be able to convince critics that it has a central plan for carrying out or improving its operations because the process of producing a POM is so ad hoc.

Finally, adjustments to the recommended plan initiated by last-minute changes will be ad hoc because the committee's objective was only to recommend the programs or sets of programs to be funded within the expected fiscal constraint or levels of fiscal constraints. Thus, when the final fiscal constraint is determined to be lower than expected, a percentage is shaved off many programs. The result is that much more money is eventually spent on the programs that have been shaved and at the same time the products of these programs are weaker. In addition, less money is available for new programs.

1.3 Principles for an Ideal Modus Operandi

Since the efficient functioning of any organization requires that it be structured around functional proponents, these proponents must rightfully be the essential elements to any procedure designed to set the funding levels in the

functional areas. However, the procedure should be structured so that the competition among proponents enhances its functioning rather than retards it. For instance, the procedure should encourage proponents to clearly define each of their programs and to openly discuss the advantages and disadvantages. The programs developed by each proponent should not depend on each other, either in terms of the final value or in terms of cost to the organization. Then, when each proponent prioritizes his programs, he should initially consider the benefits each program will yield the entire organization. Outside impacts can be factored in later so that the organization would know and could demonstrate to others the implications of these impacts.

The process of combining the prioritized lists of all the proponents should be structured in such a way that every program in every list need not be considered at that time. Rather, it should be possible for a designated group of people within the organization to become well educated about a few programs from each proponent's list and make the appropriate judgments concerning these so that all of the programs can be prioritized. Making these comparisons should stimulate discussions that result in a central defense for these funding decisions.

The final result of this procedure should then be a prioritized list of programs from all functional areas that use the relative program costs and benefits to maximize the positive impact of funding within whatever fiscal constraint is faced by the organization. Both the relative costs and benefits that are used here should be based on the life-cycle of the programs so that myopic decision making is avoided. This type of prioritized list would enable prompt deletion or addition of functional programs when fiscal changes occur, thus avoiding the reduction of many programs by a fixed percentage and the resulting bow wave problems.

1.4 Outline of this Report

Section 2.0 provides a brief description of decision analysis and a thorough discussion of the cost-benefit methodology used in POM preparation. The five applications of this methodology to Marine Corps and Army POMs are presented in Section 3.0. The application of this explicit cost-benefit analytic approach to zero-base budgeting (ZBB) is discussed in Section 4.0. Finally, Section 5.0 outlines the conclusions and recommendations of this work to date.

2.0 METHODOLOGY--DECISION ANALYSIS

Decision analysis is a quantitative method for the systematic evaluation of the costs or benefits accruing to courses of action that might be taken in a decision problem. It entails identification of the alternative choices involved, the assignment of values (costs/benefits) for possible outcomes, and the expression of the probability of those outcomes being realized. With this information at hand, one can then systematically combine the values and probabilities to show the probable gain or loss associated with each alternative choice. Since 1970, there has been a dramatic burgeoning of efforts by government agencies and the private sector to adapt this technology to their day-to-day decision making. Many have found it a way to make better, more defensible decisions.

In the application of decision analysis, a problem is structured into clearly defined components in which all options, outcomes, values, and probabilities are depicted. Quantification takes place in the form of a value or cost for each possible outcome. The probability of these values or costs being realized can be in terms of objective information or in the form of quantitative expressions of the subjective judgments of experts. In the latter case, the quantitative expression serves to make explicit those subjective qualities which would otherwise be weighted in the decision process in a more elusive, intuitive way.

Beyond its primary role of serving as a method for the logical solution of complex decision problems, decision analysis has additional advantages as well. The formal structure of decision analysis makes clear all the elements in a decision problem, their relationships, and their associated weights that have been considered. If only because the

model is explicit, it can serve an important role in facilitating communication among those involved in the decision process. With a decision problem structured in a decision-analytic framework, it is an easy matter to identify the location, extent, and importance of any areas of disagreement, and to determine whether such disagreements have any material impact on the indicated decision. In addition, should there be any change in the circumstances bearing upon a given decision problem, it is fairly straightforward to reenter the existing problem structure to change values or to add or remove problem dimensions as required.

It should be emphasized that in no sense does decision analysis replace decision makers with arithmetic or change the role of wise human judgment in decision making. Rather, it provides an orderly and more easily understood structure that helps to aggregate the wisdom of experts on the many topics that may be needed to make a decision, and it supports the skilled decision maker by providing him with logically sound techniques to support, supplement, and ensure the internal consistency of his judgments.

In fact, a decision analyst's objective is to facilitate the decision process by structuring the problem with the decision maker and eliciting the values and probabilities of the decision maker. Thus, the decision analyst is not a surrogate decision maker putting together a study that is presented to the real decision maker upon completion. Rather, he works intimately with the decision-making body to provide them a structure through which they can reach the preferred decision.

2.1 Cost-Benefit Analysis for Prioritization

Cost-benefit analysis traditionally has two distinct purposes. The first is to determine the appropriateness of

undertaking a specific action, such as building a dam or a new plant, by determining whether benefits outweigh costs and negative side effects. This is generally a difficult analysis because it is difficult to foresee all the important dimensions of such a decision and to estimate their possible outcomes. The second purpose is to achieve the most cost-beneficial allocation of a fixed level of resources among a large number of programs. In this case, the application of cost-benefit analysis is more straightforward. Basically, the relative benefits of each program must be quantified and reliable cost estimates obtained. For this type of allocation, such relative benefits are quantified according to a mission-oriented value system, not a monetary (dollar) value system.

Subjective benefit assessments can be made for very diverse programs by an elicitation procedure that motivates the proponent of a set of programs to provide his true subjective estimates. This elicitation procedure begins with the quantification of benefits for sets of similar programs, each set having the same expert proponent or sponsor. Psychologists and decision analysts have observed that the best way to obtain reliable quantifications of this sort is to use paired comparisons, that is, to ask the expert to make choices between two packages until points of indifference can be found. Once the resulting benefit scales have been assessed, each proponent is asked to provide rationale for the benefit numbers attached to his programs.

The following example is a useful illustration of this procedure. Suppose there are ten possible programs designated A through J, ranked ordinally as proposed by the sponsor. These are listed in Table 2-1, along with an initial benefit scale, total cost, and initial benefit/cost ratio. First, the program with the largest benefit/cost ratio is selected, then the order in which the remaining would be prioritized according to the cost-benefit criterion is:

J, I, D, A, F, E, B, H, G, C.

<u>PROGRAMS</u>	<u>INITIAL BENEFITS</u>	<u>TOTAL COSTS</u>	<u>BENEFIT COST</u>
A	100	16	6.2
B	99	36	2.8
C	95	56	1.7
D	90	9	10.0
E	87	30	2.9
F	83	20	4.2
G	70	35	2.0
H	70	26	2.7
I	60	2	30.0
J	55	1	55.0

Table 2-1
PROGRAMS – INITIAL COMPARISONS

This criterion guarantees that for any budget constraint, the most benefit will be obtained. Figure 2-1 illustrates the difference in benefit between the cost-benefit and benefit-only criteria for all levels of cost. Note that using the cost-benefit criterion with these benefit numbers is almost equivalent to ordering the programs by cost in descending order.

The second iteration of this process begins by comparing programs J, I, and D with A. The package J, I, and D costs nearly as much as A but should be twice as beneficial as A. However, when asked which he preferred, the sponsor said A had more benefit than J, I, and D. So A's benefit is adjusted to 250 to reflect the strength of his preference.

Next, note that A and B are nearly equivalent to J, I, D, A, and F in cost. Since A is common to both packages, and there are no interdependencies among the programs, B can be compared to J, I, D, and F. In this case, J, I, D, and F were strongly preferred, and the sponsor felt B was equivalent to J, I, and D. So B's benefit is raised to 215. In this way, paired comparisons are used to reach a level of indifference.

Through this process, the proponent develops a concept of a true zero benefit and then scales the relative benefits of his programs between zero and one hundred (assigned to the most beneficial program). The resultant ratio-benefit scale reflects the sponsor's value system.

More iterations of the paired-comparisons procedure are made until the sponsor is satisfied that the benefit numbers reflect his judgment. The normalized scale is presented in Table 2-2. The final order of cost-benefit buys is:

J, I, D, A, B, G, F, C, E, H.

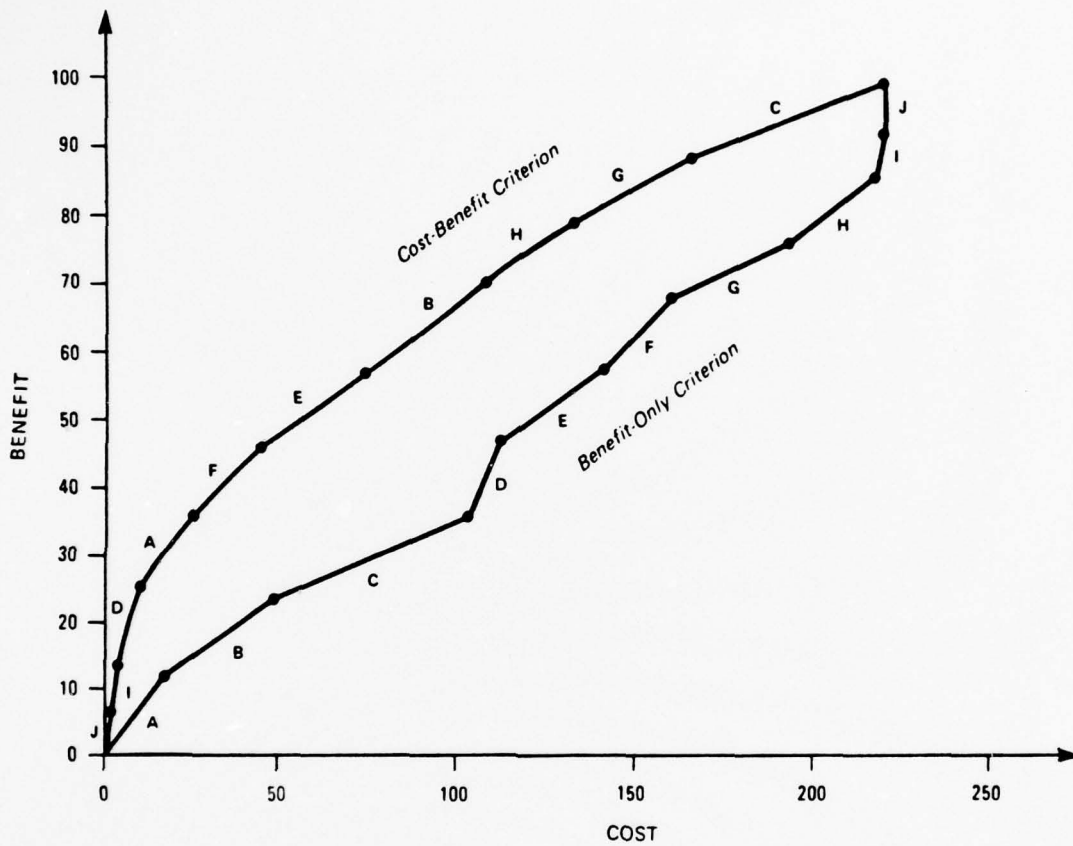


Figure 2-1
 COST-BENEFIT VS. BENEFIT-ONLY CRITERIA – INITIAL COMPARISONS

<u>PROGRAMS</u>	<u>COSTS (\$)</u>	<u>ORIGINAL BENEFITS</u>	<u>FINAL (NORMALIZED) BENEFITS</u>	<u>BENEFIT COST</u>
A	16	100	100	6.2
B	36	99	83	2.3
C	56	95	80	1.4
G	35	70	72	2.1
D	9	90	58	6.4
E	30	87	37	1.2
F	20	83	30	1.5
H	26	70	19	0.7
I	2	60	15	7.5
J	1	55	8	8.0

Table 2-2
PROGRAMS – FINAL COMPARISONS

This process helps the proponent to develop substantive rationale for supporting the final benefit scale because the judgments he has to make require more thought than is typically required to derive a simple priority list.

Figure 2-2 shows the final differences between buying with the cost-benefit criterion versus the benefit-only criterion. For a fiscal constraint of \$100, the cost-benefit criterion provides 68% of the possible benefit, which is a 33% increase over the benefit-only criterion. Clearly, to use the cost-benefit criterion effectively and to be considered fiscally responsible, the sponsors must spend considerable time producing a good set of benefit numbers reflecting the spread that they believe truly exists between their programs.

After the benefit scales and their supporting rationale have been assessed for each sponsor, a group of individuals is formed to provide a benefit scale across the diverse set of programs formed by combining the lists of all the proponents. This cross-proponent group must have a clear picture of how all of the programs might benefit the organization's effectiveness. Their job is to provide a benefit scale for a small subset of all of the decision units. The subset includes one item from each of the sponsor's lists, and the benefit scale provides the information necessary to collapse all of the individual sponsor benefit scales onto one scale. As explained in the illustration below, it is this cross-sponsor elicitation of benefits that motivates each proponent to provide his true benefit estimates. After the final benefit scale is elicited, this group must provide supporting rationale. All of the rationale and the numerical benefit scales provide the basis for the cost-benefit analysis and justification.

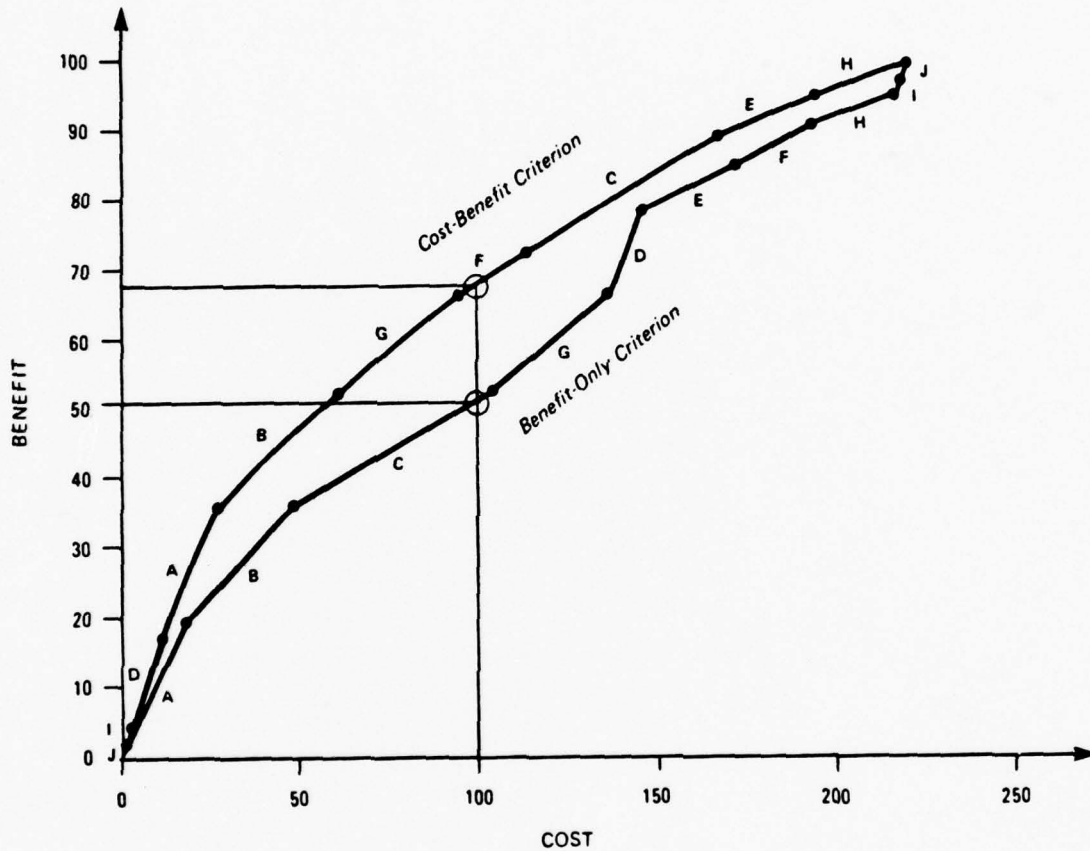


Figure 2-2
COST-BENEFIT VS. BENEFIT-ONLY CRITERIA: FINAL COMPARISONS

As an illustration of this cross-sponsor benefit scaling, consider the following two-sponsor example. Each sponsor, 1 and 2, has four programs and has assigned benefits as shown in Figure 2-3. The cross-sponsor group is asked to compare "B" and "O" and decides that "O" is twice as beneficial as "B" (Figure 2-3). (Typically, there are eight to ten proponents, and the iterative benefit assessment procedure described above for each sponsor is used.) This comparison between "B" and "O" provides enough information to rescale all of sponsor 1's programs onto sponsor 2's scale. Since "B" must be a 15 on sponsor 2's scale, the 60 on sponsor 1's scale must be divided by four, as must the benefit values of "A," "C," and "D." Sponsor 1's re-scaled programs are shown in Figure 2-4. If a sponsor contracts his benefit scale more than his true preferences would dictate, his programs may do poorly in the final analysis. For example, if sponsor 1 had claimed "B's" benefit was 90 rather than 60, his entire scale would have to be divided by 6 rather than 4 to be consistent with the belief that "B" is half as beneficial as "O".

Cross-sponsor benefit judgments are difficult to make because the programs are often so diverse. For this reason, the cross-sponsor group is asked to make two or three cross-sponsor scales, using different programs from each sponsor's list each time. This is a way of triangulating on the problem that forces inconsistencies to surface. Finding the reasons for these inconsistencies and resolving them strengthens the final result so that it is more defensible.

Once the final cross-sponsor benefit scale has been chosen, the relative benefits of all the programs are made explicit. All programs have been scaled in terms of benefit on an organizational scale. Now the benefit/cost ratios can be calculated for each program, and the programs prioritized from most cost-beneficial to least cost-beneficial. The

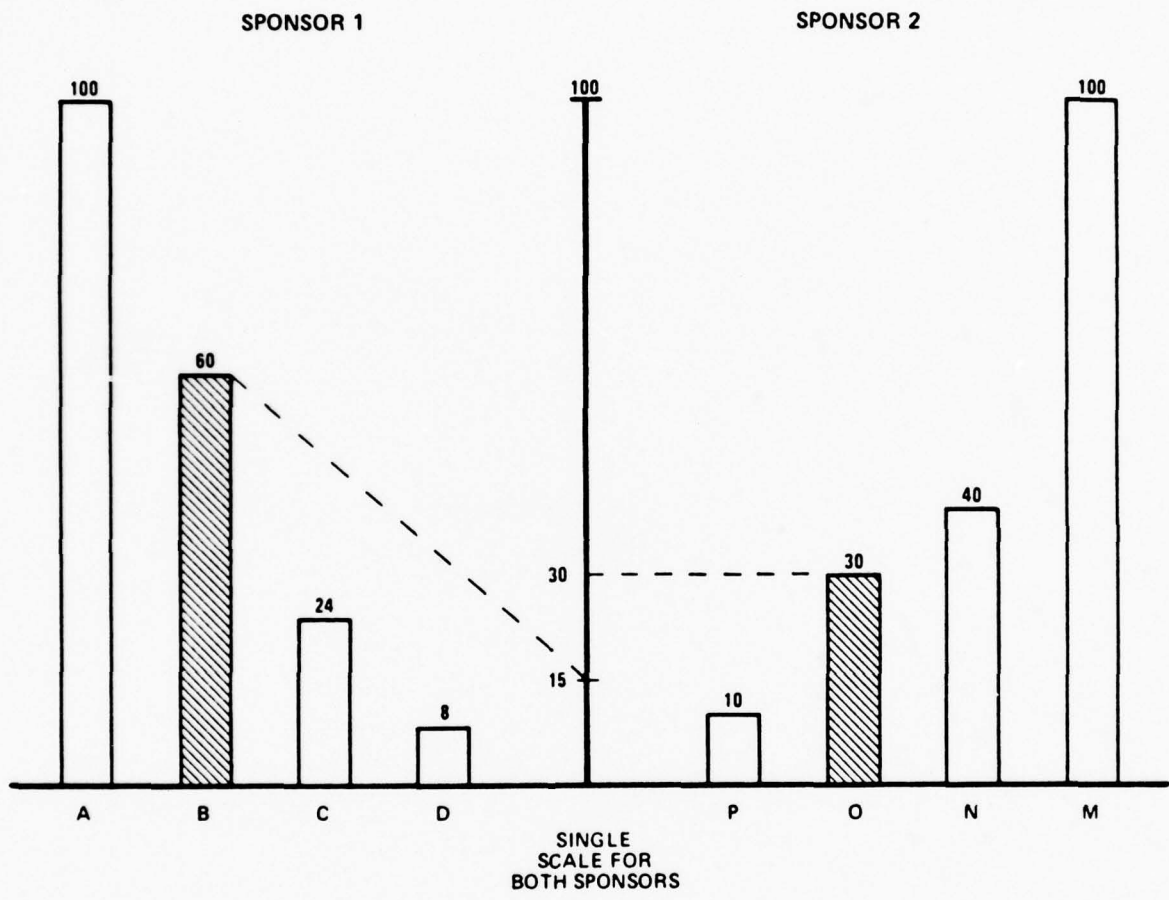


Figure 2-3
 CROSS-SPONSOR BENEFIT RANKING

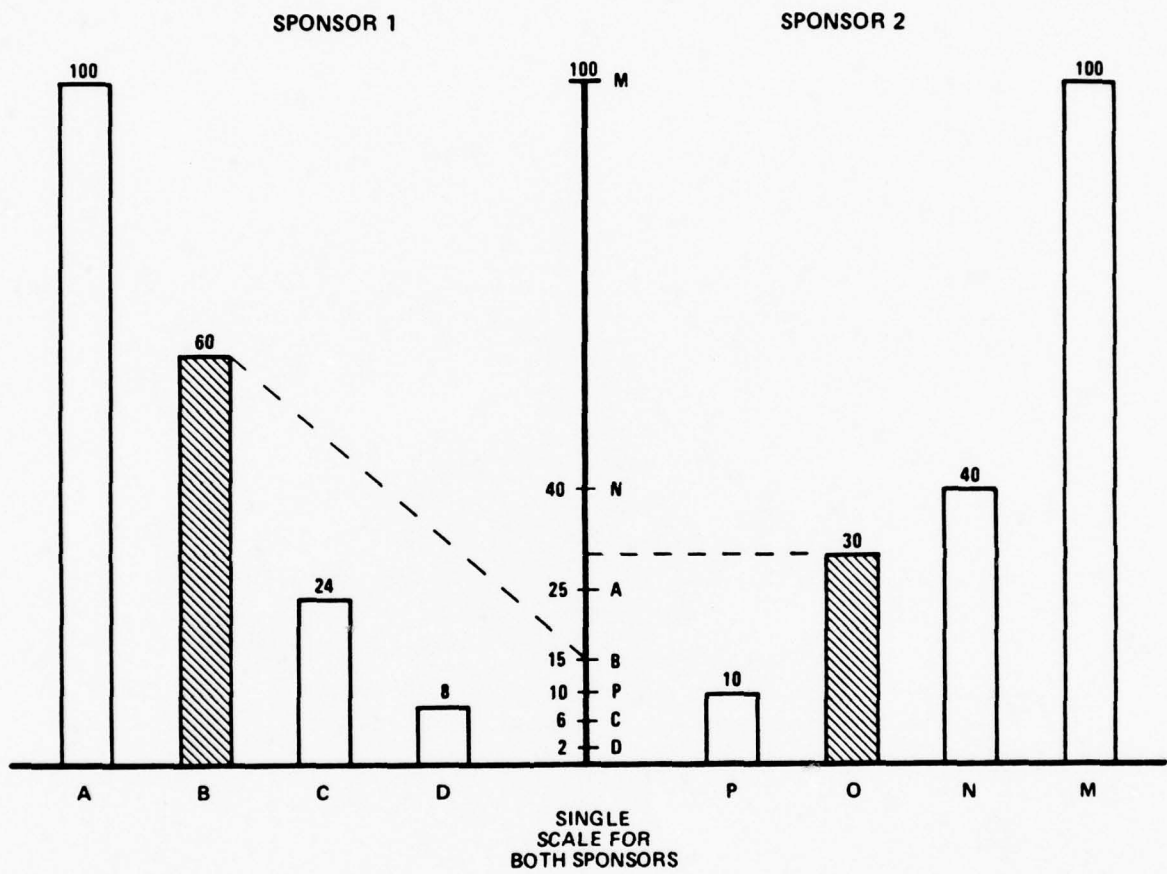


Figure 2-4
TWO-SPONSOR BENEFIT SCALE

important characteristics of this process are the way it is structured and the defensibility of the output.

2.2 Comparison of the Methodology to the Ideal Modus Operandi

This methodology uses the proponents as its foundation just as the typical modus operandi does. However, the proponents are required to provide a more detailed comparison of their programs with rationale. This rationale serves two purposes: first, it provides a clear description of each program; and second, it lays a framework for future defenses. The examination of programs by the cross-proponent group also requires a clear definition of these programs from each proponent. The benefit scales of both the proponents and the cross-sponsor group permit the prioritization of a large number of programs in a very efficient manner. The rationale provided by the cross-proponent comparisons also demonstrates a central plan for the organization. (Clearly, additional work by the organization on this problem is required to provide the centralized planning necessary.)

Cost-benefit analysis, by using incremental life-cycle costs and benefits, provides the theoretical foundation for obtaining the most benefit for the organization under its cost constraints. Benefit is, of course, measured by the benefit scales of the proponents and cross-proponents. The final cost-benefit list, adjusted to reflect the outside considerations, provides the decision rule for meeting any changes in fiscal constraints.

3.0 APPLICATIONS OF COST-BENEFIT ANALYSIS

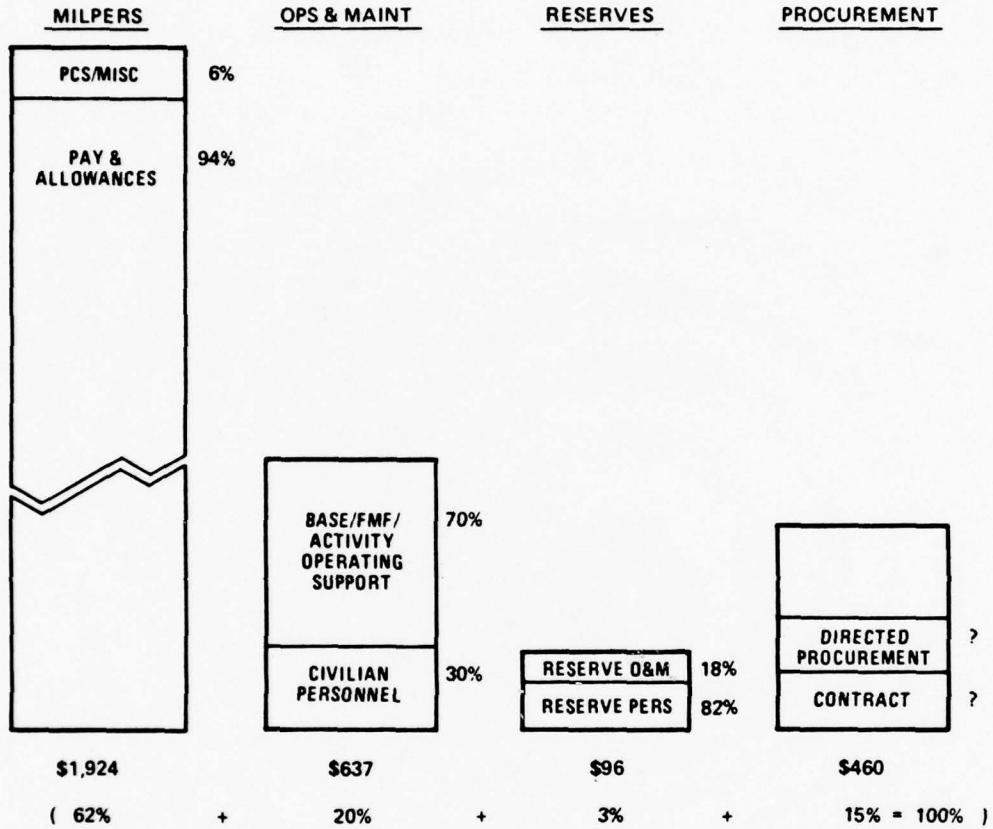
This section describes the applications that DDI has made of this cost-benefit analytic approach to the preparation of POMs for the Marine Corps and the Army. The first application was to the 1979-1983 POM (POM-79) for the Marine Corps in Fiscal Year 1977. (See [1] for a more detailed report.) Other applications, including the Marine Corps' POM-80, the prioritization of the Marine Corps Research, Development and Studies (RD&S) programs for the Navy's POM-80, the Army's POM-80 and the prioritization of Program Analysis and Resource Review (PARR) issues for the Army's POM-80, were completed in Fiscal Year 1978. (See [2] for a more detailed report on the Army POM application.)

3.1 Marine Corps' POM-79

The purpose of this initial application was to develop an improved methodology to help the Marine Corps prepare part of its portion of the Department of the Navy Program Objectives Memorandum (POM) for the 1979-1983 time period. The 1979 program year was most crucial since it would almost immediately be translated into the 1979 budget and would be subject to defense before Congress. The appropriation dollars available for manpower, operations and maintenance, reserves, and part of procurement are, to a large degree, relatively fixed and, as illustrated in Figure 3-1, constitute over 90% of a typical budget.

The most flexible and difficult decisions concerning the programming of funds were found in the procurement area, which, for programming purposes, is divided into ammunition and both current and future capabilities. Our analysis centered around the procurement of future capability items. The projected funding profile in this area for 1979 through 1983 is illustrated in Table 3-1 along with the costs of

FY-78
TOTAL TOA - \$3,117 (SM)*



*Does not include stock fund (\$2.0M)

Figure 3-1
GREEN DOLLAR DISTRIBUTION

Procurement Marine Corps (PMC)
(\$M 78)

<i>Future Capabilities:</i>	FY 79	FY 80	FY 81	FY 82	FY 83
TOA AVAILABLE	106	75	106	215	271
COST OF VALIDATED REQUIREMENTS	181	286	325	306	253

Table 3-1
POM 79

validated requirements. As shown, there are some years in which the requirements exceed the total obligational authority (TOA) available by more than 200%.

Figure 3-2 lists the eight program sponsors at Headquarters Marine Corps during 1977, each of whom sponsored various future capability programs.

- o Training
- o Installation and Logistics
- o Aviation
- o Reserves
- o Telecommunications
- o Intelligence
- o Operations
- o C⁴

Figure 3-2
SPONSORS FOR MARINE CORPS POM-79

Prior to the introduction of the cost-benefit approach, trade-offs across sponsors were made in an ad hoc manner. The use of this ad hoc method was dictated largely by the difficulty of comparing such things as howitzers, command and control systems, reserve procurements, and sophisticated communication and radar equipment. The essence of this problem is illustrated by the systems listed in Figure 3-3. Nevertheless, because of the diversity of programs and the limited amount of funds, it is important that these trade-offs be made explicit so that rational procurement decisions can be made. For example, one of the conclusions of the trade-off procedure used in this analysis was that some of the logistics programs, because of the acquisition of sophisticated equipment in the other areas, were relatively more important than traditionally thought.

MODERNIZATION (FUTURE CAPABILITIES)

Allocate Limited TOA Between Such Things As:

MULE	PLRS	RES ARTY BN	AN/UYQ-4
XM198 155MM HOW	MIFASS	RES TANK CO	AN/TPS-59
XM204 105MM HOW			MACCS-85
NIGHT VISION GOGGLES			TSC-85
LT WHT CO MORTAR			TSC-93
XM-1 TANK			PSC-1
			VINSON INSTALL KIT
			TYA()

- *And Almost 100 More Similar Proposals*

Figure 3-3

THE PROCUREMENT PROBLEM

Unfortunately, the time pressure associated with this application did not permit the estimation of the incremental life-cycle costs associated with each procurement program. Consequently, the only cost estimates for each program were the projected procurement costs for the five POM years. For this reason, the final prioritized list resembled the benefit-only prioritization more closely than the cost-benefit prioritization. The importance of good incremental life-cycle cost estimates was recognized, and efforts were begun immediately to have this information for POM-80.

An IBM 5100 mini-computer was programmed to do most of the calculations, data storage, retrieval, and manipulation needed by the working group responsible for preparation of the POM. The software in this computer was interactive in the sense that the Marine Corps officers responsible for POM preparation were able to use it after a very short instructional period without the assistance of a computer programmer. They could make changes to the data and ask for new displays/printouts at their own convenience without relying on others

or waiting in the queues often associated with large computer systems. Their turn-around time was on the order of minutes or hours, and they could take the computer to meetings and briefings with them. This gave the officers a high level of confidence in the output of the computer because they were controlling the inputs as well as the computer processing themselves.

The cost-benefit approach also facilitated the rapid identification of the real decision points; that is, that subset of procurements in the "gray area" of the decision-making process quickly surfaced. Consequently, most of the subsequent discussion was focused on the troublesome subset rather than spread evenly across all the procurements. For instance, there were a few procurements that senior officers felt a priori should be funded. However, when the final analysis indicated otherwise, the POM working group was able to show with considerable ease which other procurements would then have to be sacrificed. In all cases, this type of comparison was convincing.

A major decision point for POM-79 surfaced immediately after all of the benefits were assessed and entered into the computer. The expected TOA's for the five-year period 1979-1983 were very uneven, with a minimum in 1980 (Table 3-1). The 1980 TOA had been known for some time, but its impact was not clear. However, both the cost-benefit and benefit-only orderings indicated that there was a higher rate of expenditure of funds in FY 1980 than in any other fiscal year. Since the Marine Corps does not have a bank available for smoothing out cash-flow problems, this was serious. In fact, after a short analysis indicated that the rearrangement of a few procurements would not solve the problem, it became clear that a major restructuring of the procurement outlays was required. The sponsors were asked to provide several alternative funding profiles for all procurements

requiring 1980 funding. Short descriptions of the disadvantages of these alternatives were also provided, including any changes in benefit numbers. The computer software was then used to iterate towards the solution of this problem in a short period of time.

In the past, there have been sponsors who were very displeased with the final POM decisions and felt that their procurements were funded at a lower level than optimum. Since the sponsors were uncertain about how much control they had over the outputs of the cost-benefit approach, they were initially skeptical. However, not only were all the sponsors satisfied that the approach had been useful and educational, but those who were in a position to feel short-changed were satisfied that they had been treated fairly.

Several factors contributed to the sponsors' satisfaction with the cost-benefit approach. First, the logic and recorded rationale for the quantified benefits gave people confidence that all of their inputs were being used. Second, the process of eliciting benefits generated a substantial amount of discussion--discussion that resulted in the education of many more people concerning the pros and cons of each of the procurements. This educational process involved the generalists as well as the experts. It gave the sponsors more understanding of each others' programs, which, in turn, resulted in a greater understanding of the decisions that were made.

The Marine Corps programmers responsible for putting the POM together had to supervise a committee of experts (the sponsors) to complete its job. Committees are necessary when diverse technical information must be digested and summarized. However, it is often difficult to focus committee debates on important topics; they tend to ramble, resulting in a significant waste of time. By using the cost-benefit

approach, the supervisors found that they had much more control than usual because they could adjourn the committee meetings when the discussion began rambling, analyze several alternatives to the solution of the committee's various problems, and then put a recommendation before the committee for specific comments. This expedience was possible only because of the logic of the cost-benefit approach and the group's direct access to the computer.

3.2 Marine Corps POM-80

The second application of the cost-benefit analysis to the preparation of the Marine Corps POM was expanded in scope. Part of this expansion was planned and part was necessitated by the fiscal constraints under which the Marine Corps had to operate. Initially, there were ten sponsors (Figure 3-4) for this application. Four of these

- o Installation and Logistics (I&L)
- o Aviation
- o Reserves
- o Intelligence
- o Operations and Training (O&T)
- o C⁴
- o Ammunition
- o Manpower
- o Research, Development and Studies (RD&S)
- o Operations and Maintenance (O&M)

Figure 3-4

SPONSORS FOR MARINE CORPS POM-80

(Ammunition, Manpower, RD&S, and O&M) were new. Telecommunications and training were added to C⁴ and Operations,

respectively. The Ammunition and RD&S programs were very similar in purpose to the PMC programs considered in POM-79; however, the characteristics of Manpower and O&M programs differed vastly from other PMC programs. For instance, unit deployment and job enrichment were two Manpower programs. Since there was significant value dependence among increments of the program elements that define the O&M appropriation, the O&M programs were packages of program elements as illustrated in Figure 3-5.

The benefit scale relating the programs of all ten sponsors was developed, as described in Section 2.0, by working with each sponsor first and then convening a cross-proponent group that took three cuts across the ten sponsor scales.

This year, a more concerted effort was undertaken to estimate the incremental life-cycle cost of each program. The cost form filled out for each program initiative is displayed in Figure 3-6. The appropriate costs are incremental, and several programs were advertised via these forms as net cost savers. Since these programs should be funded whenever their benefits are positive, considerable attention was focused on them; an additional form (Cost Savings Worksheet, Figure 3-7) was generated to document the cost savings for validation. One program (the Conceptual Vehicle Fleet) was validated as having a net constant dollar savings over its life cycle. (Constant dollars are the appropriate dollars to use in calculating the incremental life-cycle cost of the programs; year or FYDP dollars overemphasize the importance of dollars in the future. Discounting constant dollars, on the other hand, underemphasizes the importance of dollars in the future.)

However, just as the prioritization of these programs was being completed, the Marine Corps' fiscal guidance from

O&M PACKAGE 1

Summary:

The Package 1 increment will enable Land Forces to fund for all O&MMC training, administrative logistics, material, and personnel support costs required to maintain readiness; readiness will be attained for combat essential equipment. The Package 1 increment will enable the Central Supply Activities to support adequately the materiel requirements of the FMF; the increased staffing of the inventory control operation will reduce backlog and improve supply performance. All Logistics Support areas (Second Destination Transportation; Readyline and PWRS maintenance, and centrally managed logistics programs) will be increased to the level where they will adequately support operating force requirements.

Contents:

Package #1	(\$000)
Land Forces	\$ 7,631
Land Forces	
New Equipment	202
Initial Issue	402
Central Supply Activities	
ICP Operations	616
Supply Depot Ops	481
Supply Support	766
Logistics Support Activities	
Second Destination Trans	823
Official Mail	339
Centrally Managed Logistics Support	981
	<hr/>
Total	\$12,241
Benefit: 100	

Figure 3-5
EXAMPLE OF O&M PROGRAM

	FY79	FY80	FY81	FY82	FY83	FY84	TOTAL POM80	OUTYEAR COST/QTY	TOTAL LIFE CYCLE COST/QTY
QUANTITY									
*COST IN FYDP \$M									
R&D (MC)									
JOINT									
**MPMC									
O&M, MC									
PMC									
O&M, MCR									
**RPMC									
MILCON									
TOTAL									

* For purposes of program development, DC/S for R&P will convert these costs to constant FY79 dollars. (Program sponsors will be provided with the FY79 constant dollar data).

** Reflect costs associated with net increases/decreases in manpower required as a result of this initiative.

Figure 3-6
COST IDENTIFICATION FORM

ITEM	80	81	82	83	84	O/Y	LC
CC O&M							
FC O&M							
Δ O&M							
CC PMC							
FC PMC							
Δ PMC							
CC MPMC							
FC MPMC							
Δ MPMC							
TOTAL Δ's							

LEGEND

FC = Future Capability
 CC = Current Capability
 Δ = Changes

Figure 3-7
 COST SAVINGS WORKSHEET

the Navy was finalized. The cost of their core exceeded the decremental funding level and was nearly as great as the basic level in the early POM years. For this reason, a new prioritization of programs, carved out of the core, was undertaken. The sponsors for this prioritization were based on the Marine Corps appropriations (Figure 3-8). There were a total of 28 programs in this prioritization, examples of which are presented in Figure 3-8. Most of these programs are packages of items that are interconnected to meet a certain function; for example, one aviation package consists of the Marine Corps personnel required to fill a training squadron from 90% to 100% of its proper strength. This prioritization procedure was more important in the end than the initial one because the OSD focuses mainly on the programs between the decremented and basic funding levels.

<u>Sponsor</u>	<u>Example Programs</u>
Manpower (Ground) - O&T	Personnel Package
Manpower (Air) - Aviation	Personnel Package
Manpower Reserves	Platoon Leader Course
O&M	Depot Rebuild Package
O&M Reserves	Recruiting Support
Current Capability	Initial Issue Package
Procurements	

Figure 3-8

SECOND PRIORITIZATION FOR MARINE CORPS POM-80

3.3 Marine Corps RD&S Programs for POM-80

For POM-80, the RD&S funding profiles were reduced by 4%, while several major programs were growing substantially. The result was an excess of \$30 million per year in requirements above the available funding. The sponsors of RD&S

programs include Manpower and the five sponsors within the Procurement appropriation (Figure 3-9).

- o O&T
- o I&L
- o C⁴
- o Aviation
- o Intelligence
- o Manpower

Figure 3-9
SPONSORS FOR RD&S PROGRAMS

The programs considered in this process are of four basic types:

1. a full-scale R&D program;
2. an R&D investigation of modifications to existing systems;
3. the final DT/OT (Development Test/Operational Test) for a completed R&D project; and
4. monitoring the R&D activities of other services.

For the first type, both current and future expenditures are quite large, so the benefits of such a program have to be significant in order to justify funding. The second type (investigation of modifications) is typically very cost-beneficial when expenditures are small; but as funding requirements increase for this type, there is a point at which a full-scale R&D program is more practical. The third type of program involves funding for tests that are required by DoD. A proposed item must pass these tests before the

service can procure it. At this point, substantial R&D dollars have been invested in the program; and, theoretically, the test should be conducted only if the Marine Corps can afford to procure the item within the POM fiscal constraints. Finally, the fourth program type is the most common in the Marine Corps since its budget is much smaller than those of the other services. The benefits to be derived from this expenditure of resources are primarily those associated with information.

The benefits were elicited from the proponents and cross-proponent group as described in Section 2.0. In this application, one of the proponents had twenty programs, two of which were particularly high on visibility; they were assigned benefits to reflect this visibility. However, the cross-proponent group, while agreeing with the high-visibility nature of the programs, did not agree that their benefits should be exceptionally high. This resulted in significant inconsistencies among the three cross-proponent benefit scales that could not be resolved. The proponent permitted the cross-proponent group to develop a benefit scale for all twenty programs that was very consistent with their judgments concerning the three programs involved in the cross-proponent deliberations.

Once agreement was reached on this overall benefit scale by the Chief of Staff's Committee (the senior committee responsible for POM development), each of the seventy-four programs was divided into increments. This was done to be consistent with zero-base budgeting and because it was felt that there was some "fat" in some of the good programs. The benefit number associated with each of the programs was then divided among that program's increments. Ideally, these increments should be formed prior to the benefit elicitation to achieve the motivational characteristics inherent in the elicitation process.

The RD&S programs were prioritized by benefit in this application because the only cost estimates available for each were for the five POM years. Clearly, there are significant outyear costs for these R&D programs being developed for procurement. Since funding an R&D program that cannot be afforded if developed is not a wise expenditure of resources, a concerted effort is currently underway to obtain the appropriate life-cycle cost estimates for POM-81.

If the benefit-only prioritization had been followed, forty-one of the seventy-four programs would not have been funded at the enhanced level, and only thirty-one would have been funded (either partially or fully) at the basic level. This was not deemed satisfactory, so some of the increments were reprioritized by using other considerations such as cost-effectiveness. The result was that forty-two programs were funded at least partially at the decremented level, twenty-one more at the basic level, nine additional at the enhanced level, and only two programs were not funded at all.

3.4 Army's POM-80

There were 185 Program Development Incremental Packages (PDIPs) being considered above the Army's core in the POM development. (The ten proponents of these programs are listed in Table 1-1.) Clearly, the spectrum of PDIPs supported by these proponents is wide, as evidenced by the examples in Table 3-2. Summary sheets for PDIP's were prepared by the proponents and contained a funding profile, narrative description, and rationale/analysis for the benefit numbers. Only estimates of the five-year POM costs for these PDIP packages were available for this application. Recommendations have been made to the Army that life-cycle costs (constant dollars) be used next year.

SPONSOR	PDIP TITLE
DCSOPS	National Training Center NATO Forward Deployed Readiness DS/GS Maintenance (USAREUR/FORSCOM) USAREUR DIV ALO Increase Flying Hour Program U.S. Contribution to NATO Military Budget
DCS RDA	M60 Tank Production GSRS REMBASS Air Cushion Vehicle (ACV)
DCSPER	Quality of Life Enhancement/ELIFE TAG No. 1 Women in the Army (WITA) Decision Package Set No. 40 Training Developments - Current Program Civilian Training, Education, and Development Program Organizational Effectiveness
OCAR	USAR Readiness (M to M + 30)
NGB	M to M + 30 Force
AAD	Readiness Automation Modernization Mobilization Automation Interoperability Project VIABLE, Phase 1 Automation Modernization I Automation Modernization II

Table 3-2
 REPRESENTATIVE SAMPLE OF PDIPs

SPONSOR	PDIP TITLE
DCS LOG	Support Readiness - Property Accountability NATO Task Force: Consumer Logistics
OCE	Training/Operational Efficiency - MCA Sub-Package Construction in Panama - MCA Sub-Package Korea Relocation - MCA Backlog of Maintenance and Repair - Europe
PA&ED	Readiness #1 (PARR's) Management #1 (PARR's) Modernization #1 (PARR's) Materiel #1 (PARR's) Human #1 (PARR's)
OTSG	Preposition 18 Reserve Component General Hospitals in Europe Military Occupational Health/Safety Hazards International Health Initiatives

Table 3-2
REPRESENTATIVE SAMPLE OF PDIPs
(Continued)

The PDIP's of the Army Automation Directorate (AAD) provide a useful illustration of the relative benefits ascribed by each proponent to his PDIP's. AAD's PDIP's are described in Table 3-3 in terms of five-year costs, relative benefit numbers, and benefit/cost ratio. With these costs and benefits, the cost-benefit priority order for AAD's PDIP's was:

1. Interoperability
2. VIABLE
3. Modernization I
4. Modernization II
5. Readiness
6. Mobilization
7. Modernization

This priority list was supported by AAD. The benefits reflect the following judgments:

- o VIABLE is equal to the other six PDIP's in benefit.
- o Interoperability is over twice as beneficial as the combination Modernization I and II, Readiness, Modernization, and Mobilization.
- o Modernization II is slightly more beneficial than Modernization I, Readiness, and Mobilization.
- o Modernization, Modernization I, and Readiness are more beneficial than Modernization II.
- o Readiness is equal in benefit to Modernization and Mobilization.

The benefit numbers for all of the sponsors were elicited over a two-week period by interacting with the action officers of each proponent.

PDIP	5-YEAR COST	BENEFIT	BENEFIT/ COST
VIABLE	147.	100.	0.68
Interoperability	30.	70.	2.3
Modernization II	35.	13.	0.37
Modernization I	18.	7.	0.39
Readiness	20.	5.	0.25
Modernization	232.	4.5	0.019
Mobilization	19.	0.5	0.26

Table 3-3
AAD'S RELATIVE COSTS AND BENEFITS

Two cross-sponsor benefit scalings were assessed from the "Rump" Program Guidance Review Committee (PGRC). These scales contained a number of inconsistencies that were discussed with the "Rump" PGRC and resolved shortly thereafter by the action officers. Table 3-4 provides an implied cross-sponsor benefit scale for one PDIP from each sponsor's list in Table 3-4. The implied benefit scale is derived from the final benefit numbers of this POM prioritization. A set of judgments similar to those discussed above for packages of AAD's PDIP's can be constructed for these cross-sponsor PDIP's.

Following the cost-benefit analysis, the outside considerations discussed in Section 1.0 were addressed. The resulting deviations were both visible and quantifiable to the top-level decision makers. Thus, the impacts of political and other legitimate (non-mission) parameters are visible; and this visibility provides the top-level decision makers with a means to grade their efforts.

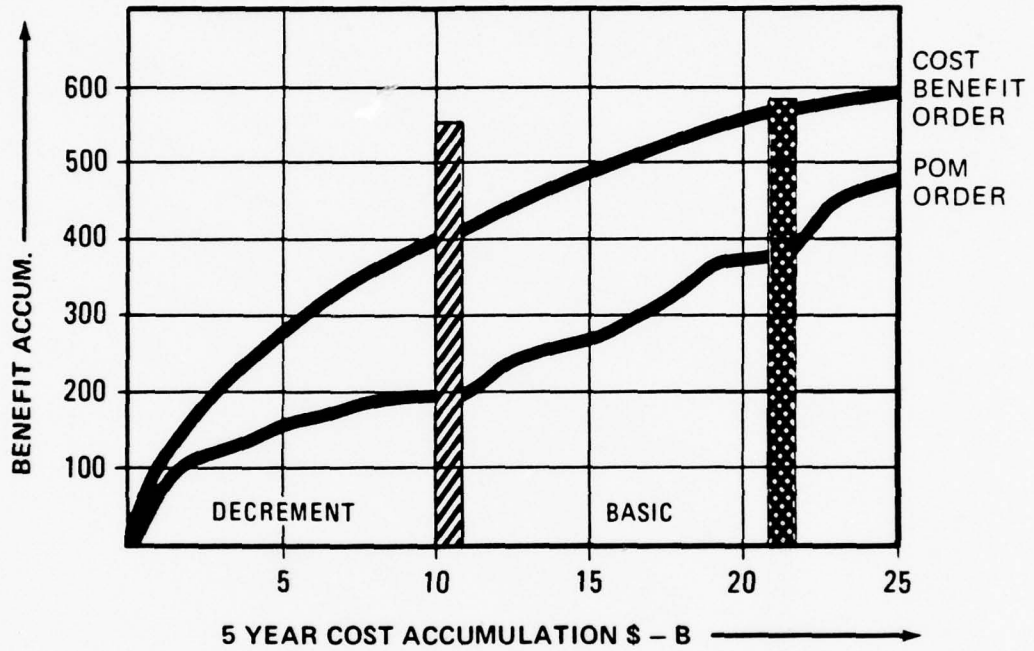
Figure 3-10 presents a graphical comparison of the two prioritizations. The vertical axis represents accumulated benefit as PDIP's are bought by each prioritization; the horizontal axis represents accumulated five-year cost. At the decremented level of funding, the POM order accounts for only half the benefit that the cost-benefit order does. The POM order is very similar to the cost-benefit order between the decrement and basic levels. As a result, the POM order results in two-thirds the benefit of the cost-benefit order. Several reasons for these differences are also listed in Figure 3-10.

Since OSD-directed initiatives, program imbalance, and so forth are facts of life, this cost-benefit prioritization was represented to the decision makers as a good place to start but not the final answer. There were several reasons for this recommendation:

SPONSOR	PDIP	CROSS-SPONSOR BENEFIT	5-YEAR COST	<u>BENEFIT</u> <u>COST</u>
PA&ED	Readiness #1	100	134	.75
OCAR	USAR Readiness (M to M + 30)	81	165	.49
DCSOPS	DS/GS Maintenance	80	114	.70
NGB	M to M + 30 Force	79	552	.14
OCE	Construction in Panama	63	30	2.1
DCSPER	ELIFE	59	136	.43
AAD	VIABLE	34	147	.23
DCSRDA	M60 Tank Production	16	317	.050
OTSG	18 R.C. Hospitals - Europe	5.3	24	.22
DCSLOG	NATO T.F.: Consumer Logistics	2.5	66	.038

Table 3-4
CROSS-SPONSOR BENEFIT SCALE

PROGRAM EVALUATION



Deviations . . . due to

- SOME OSD DIRECTED INITIATIVES
- MUST PAY BILLS
- PROGRAM IMBALANCE

Figure 3-10
COMPARISON OF POM WITH COST-BENEFIT ORDER

- o Benefit numbers represent the Army's effectiveness only. Attributes involving political, economic, and other issues must also be considered.
- o Some of the PDIP's were dependent upon one another, such as the (1) creation and (2) deployment of a major unit.
- o Only the five-year POM costs were used. Abnormally high outyear costs of certain PDIP's should be used to reduce their priority.
- o Manpower constraints have to be considered in the final prioritization.
- o This analysis is only conducted at the margin and, therefore, does not flush out "gold watches" (soft programs) in the core.

Additionally, the decision makers used this cost-benefit prioritization to determine how to spend \$189M not specifically earmarked in FY 80 in the basic level of the initial POM prioritization. This enabled the decision makers to move the POM priority order closer to the cost-benefit prioritization.

3.5 Program Analysis and Resource Review (PARR) Issue Prioritization

The overall goal of the PARR prioritization was to rank (in a three-day period) 334 PARR issues by using the previously described cost-benefit methodology. Fifteen Army Staff analysts were the experts who specified the benefit numbers. These analysts knew the PARR issues and were familiar with the Army goal categories depicted in Table 3-5. The PARR

issues were categorized by both command and functional categories.

- o Readiness
- o Human
- o Materiel
- o Strategic Mobility
- o Modernization/Future Development
- o Management

Table 3-5

FUNCTIONAL CATEGORIES OF ARMY GOALS

Prior to this prioritization, nearly 800 PARR issues underwent a Sieve Analysis during which the following PARR issues were removed from consideration: 1) issues funded within basic levels of the major commands (MACOMs); 2) issues included in PDIPs; and 3) issues not supported by the Staff. This Sieve Analysis resulted in the set of 334 PARR issues to be prioritized.

The first step in the prioritization was to generate a "marker" list of approximately eighty representative PARR issues. The purpose of this "marker" list was to provide a benchmark of benefits spanning the diversity of PARR issues, such that benefit numbers could be quickly and reliably assigned to the remaining PARR issues. Table 3-6 is a categorization, by functional category and by command, of the eighty-seven-item marker list which was settled upon by the participants. For this analysis, the Material and Strategic Mobility categories were combined into one category.

Having selected the eighty-seven-item set of markers, the next step was to evaluate the benefits of PARR issues for each of the nineteen cells in the matrix of Table 3-6. For example, the EUR-KOR Command was required to produce

benefits for its nine readiness items by first assigning a benefit of 100 to the most important single item and then adjusting the benefits of the other eight readiness items appropriately. The other commands similarly established benefits for their marker list PARR issues within each of their functional categories.

The next step in constructing the overall list of benefits for the marker list was to combine the marker items from each command into a single list for each functional category. To accomplish this task, command analysts met and adjusted the benefits of a single highly beneficial item in each command to some mutually agreeable magnitude. Next, items from the middle of each command's benefit list were adjusted in benefit. Finally, a similar adjustment was made for items ranking low on each command's benefit list. The benefit lists were then compared to see whether they reflected the same benefit proportionality among commands. If not, readjustments were made both within and between command lists to achieve a final between-sponsor proportionality. The remaining items in each command's category list were then rescaled to correspond with the new benefits for the previously rescaled items on each list. Each command's portion of PARRs for the designated category was directly integrated to form a single category marker list. The participants reviewed each integrated category marker list and altered the benefits until a level of indifference among combinations of packages was achieved. Any adjustments, however, required the mutual consent of the participants.

At this point in the analysis, there existed five separate marker lists, each corresponding to a different functional category, which now had to be combined into an overall marker list. To perform this task, the relative magnitudes of the items with high, medium, and low benefit on each category marker list were adjusted. An iteration to

"MARKER"
PARR ISSUES

		Readiness	Human	Materiel	Moderniz'n	M'gmt
EUR-KOR	11	9	5			2
TRADOC-HSC	6	5		6		2
DARCOM	3	2	6			
FORSKOM	8	2	1			4
ACC	7	1		3		4
TOTAL	35	19	12	9		12

Grand Total 87

Table 3-6
BREAKDOWN OF "MARKER" LIST

establish consensus levels of indifference on these adjustments then took place, and the remaining items on the lists were rescaled appropriately. The category marker lists were combined into the final overall marker list, and all participants were given the opportunity to adjust the benefits of any items on the list. Once again, these adjustments could be performed only by mutual consent.

The cost-benefit implications of the benefits assessed for the marker list were then calculated, and the participants once again adjusted the benefits for these items. For the first time, the real meaning (in a cost-benefit sense) of the benefit assessments surfaced, and as a result, some drastic changes in benefit assessments took place. With the first set of benefits, the chief problem was that the range of the benefit scale was much smaller than the range of the cost scale. Since most participants felt this to be untrue, the benefit scale was expanded. As always, benefit alterations were made only through mutual consent of all participants. The result at this point was a benefit scaling of all eighty-seven marker issues. The successive iterations described above had converted an ordinal ranking to a numerical ratio scale of benefits. This benefit scale could now be compared to the cost scale so that a cost-beneficial prioritization could be established.

Figure 3-11 contains a plot of cumulative cost versus cumulative benefit for these marker issues. The lower curve in this figure assumes that items are purchased in order of benefit, highest to lowest; the upper curve assumes purchasing in the order from lowest to highest cost/benefit ratio. The two plots clearly illustrate the tremendous gain in accrued benefit which results when the cost-benefit rather than the benefit-only purchasing strategy is used.

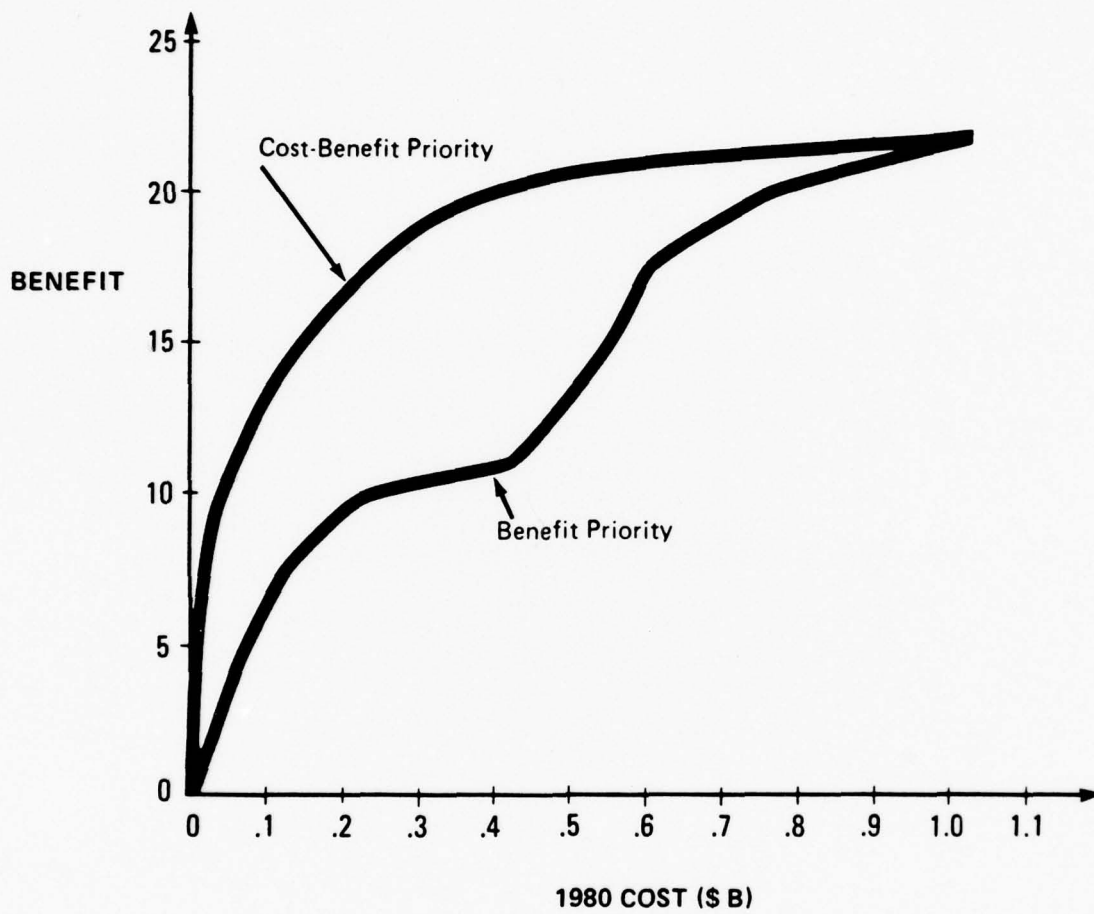


Figure 3-11
 COST-BENEFIT VERSUS BENEFIT-ONLY CRITERIA –
 PARR ISSUE "MARKER" LIST

Before the prioritization continued into the phase of integrating the 247 remaining PARR issues into the marker list, the participants were asked to supply rationale for the relative placements of a portion of the marker items with respect to one another in the category marker lists.

The final step in establishing the benefit list was to integrate, according to functional category, the 247 remaining PARR issues with those contained in the marker list. That is, the remaining PARR issues for each functional category were compared with issues of the same functional category in the marker list and assigned benefits. This process produced five separate lists of PARR issues (one for each functional category) to which benefits had been assigned on a common scale.

Before integrating these five lists into a final overall benefit list, the benefit lists by category were rank-ordered with respect to benefit and cost-benefit. The costs assessed were the FY 80 costs in thousands of dollars. Participants then studied the implications of these lists in terms of purchasing priority and adjusted benefit values which led to seemingly inappropriate implications. All adjustments were performed only by mutual consent among participants, and supporting rationale was provided.

The last step in the exercise was to combine the category benefit lists into a total PARR issue list. Although cross-referencing among the five category lists could provide the same amount of information, a single overall list made it easier to perform a final validation of benefit values and their implications. In this final iteration, benefit values could once again be adjusted by mutual consent of participants. The resulting overall benefit list could be used to establish buying priorities for all PARR issues across all functional categories.

Figure 3-12 displays, for the overall list of 334 PARR items, the cumulative cost versus cumulative benefit for both benefit only and cost-benefit purchasing strategies. Once again, this display makes overwhelmingly clear the tremendous advantage in terms of benefit purchasing power to be gained from the cost-benefit versus the benefit-only purchasing strategy.

The final results of this PARR issue analysis and prioritization were an overall list of PARR issues ordered by benefit, an overall list of PARR issues ordered by cost-benefit, and a set of supporting rationale for the marker issues.

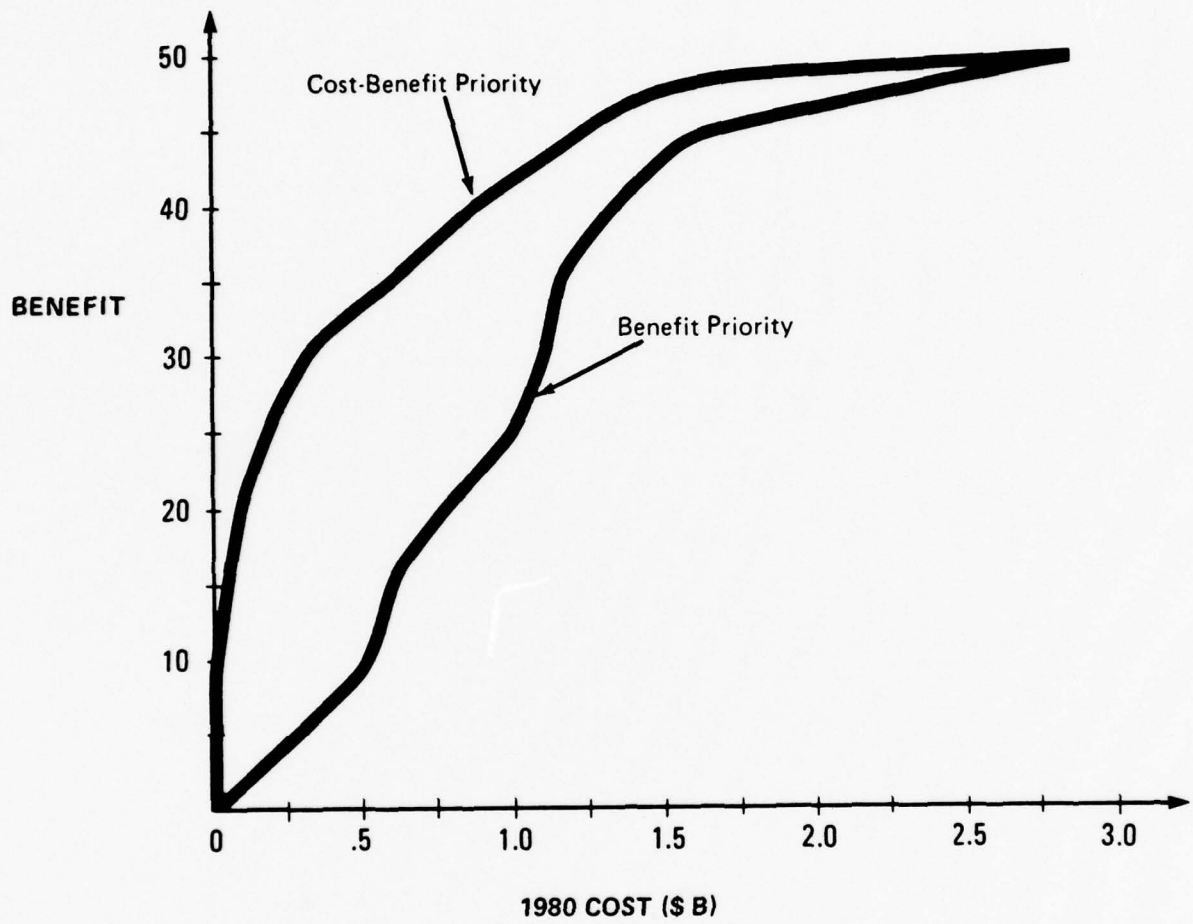


Figure 3-12
 COST-BENEFIT VERSUS BENEFIT-ONLY CRITERIA -
 PARR ISSUES

4.0 THE APPLICATION OF THE COST-BENEFIT METHODOLOGY TO ZERO-BASE BUDGETING

Zero-base budgeting (ZBB) is both a planning and a budgeting procedure developed to achieve a cost-beneficial budget by requiring the justification of entire programs during every budget cycle. Incremental budgeting, which ZBB typically replaces, often allows programs to survive, and even grow, long after their useful contributions have ended. Zero-base budgeting, on the other hand, ensures that only the most relevant programs (as determined by the accompanying justifications) are funded.

In ZBB terminology, programs are called decision units, and the manager responsible for a decision unit must define several levels at which it can be funded. These levels are called decision packages. Managers responsible for several decision units are asked to rank the packages of these units in a cost-beneficial ordering. This ordering is then forwarded to a higher-level manager who receives similar inputs from others. The higher-level manager must prioritize the packages of all of these managers but has some latitude for changing the priorities he has received. At some point in the prioritization process, he combines decision units and/or packages in order to keep the number of packages manageable. (This procedure of combining decision units is a very necessary element in the ZBB process but one that has not been developed very well for practical applications.) This higher-level manager then forwards his ordering to his superior in the chain of command, and the process repeats itself until the ultimate decision maker is reached.

The following discussion illustrates the application of the cost-benefit analysis described in Section 2.0 to hierarchical organizations using ZBB.

First, the lowest-level managers who prioritize the packages of several decision units should use the cost-benefit procedure to explicitly assess benefit numbers. (With the standard ZBB approach, the managers assess benefit numbers implicitly.) Before forwarding the cost-benefit ordering of packages and the benefit scale from which it was derived, the manager appropriately documents the judgments he made in establishing this benefit scale. Such documentation is valuable because it provides his superior with an understanding of how the benefit numbers were derived. Without this, the higher-level manager might make changes to the scale without fully appreciating the rationale underlying it.

A strong argument for making these benefit judgments explicit rather than implicit is that it forces the manager to formulate and understand his objectives. The objectives of each program provide the framework for the potential benefits to be realized from the programs under consideration. Making these benefit judgments explicit and available for scrutiny at every tier of the decision process is basic to the ZBB philosophy of justifying every program anew during each budget cycle.

The benefit scales can also be used to great advantage at the higher tiers of the decision-making process. For example, this information is very useful to upper-level managers when they combine the packages of decision units from several different managers. These packages should be similar in the objectives that they satisfy, but they should also be nearly equivalent in terms of cost-benefit. The benefit scales provide the necessary information to ensure this equivalency. Otherwise, a "piggy-backing" arrangement results that tends to produce an unbalanced budget.

However, the benefit scales (with supporting rationale) are perhaps most useful to the higher-level manager when he prioritizes the packages of decision units for several managers. With the current ZBB approach, he receives a number of orderings and must decide how to rank every package from the various lists. To make the very large number of comparisons required, the manager must have sufficient knowledge of each decision unit and the benefits associated with the incremental packages. With the cost-benefit approach, he makes the adjustments he feels are required to each manager's benefit scale and then makes the few benefit judgments needed to merge the several scales into one. Basically, he takes only one decision package from each manager's list and specifies a benefit scale for these packages. This scale contains the information needed to transform all of the lower-level managers' scales into one. Thus, this upper-level manager is only required to educate himself about a few of the packages.

Since these benefit scales are subjective, it would be wise for the manager to select two or three sets of packages, each set containing a package from each manager's list. The elicitation of benefits for each set will then expose inconsistencies that can be noted and resolved; this strengthens the final product. The final benefit scale, together with the supporting rationale for both the across-manager judgments and the within-manager judgments, is forwarded to the manager at the next higher tier of the decision-making hierarchy. As this process continues, the rationale expands to document all of the judgments made, so that questions subsequently raised by higher-level decision makers may be answered.

An added benefit of this entire process is the motivation it provides to those managers who are assigning benefits. That is, a manager who wants to maximize the inclusion of his decision packages in the final budget will not "game"

the system, but will provide his true subjective benefit scale. This is a necessary attribute of the system since upper-level managers must trust the judgments of their subordinates, who are trying to sell all of their programs.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The application of the cost-benefit approach to the prioritization of POM programs has been successfully introduced to both the Marine Corps and the Army. Several reasons account for this success. First, the procedure is a perfect match with the staff organizations of both the Army and Marine Corps. This compatibility is important because the normal conduct of business remains unaffected and because the proponents of the various programs under consideration have a functional orientation. This functional orientation is critical to making clear-cut "go - no go" decisions about these programs. The development of benefit scales is the type of activity each proponent ought to be doing as a summary of his expertise for the decision-making process. Finally, the benefit judgments made across benefit scales by the highest level decision-making body incorporate the considerations for which this body has responsibility while requiring sound education about a minimal number of the many programs.

This prioritization procedure is founded upon the principles of cost-benefit theory because of the reality faced by the service organizations (as well as by most others): a fiscal constraint that must be met. Clearly, many other constraints, such as manpower ceilings and directed programs from OSD, impact the decision-making process. Our suggestion has been to use the cost-benefit priorities as a point of departure for considering deviations that will satisfy the other constraints. The fiscal constraint is the most critical of all, and the measurement of deviations from the cost-beneficial prioritization of programs is an important factor to be brought out in discussions with OSD, OMB, and other reviewers of the POM recommendations.

The cost-benefit criterion permits the proper use of life-cycle cost estimates at the proper time. Recent discussion has centered around the large dollar outlays that will be required in the future to operate and maintain the weapon systems being introduced now. However, were it not for the cost-benefit criterion, the relative impacts of these costs would not have entered into the decision-making process.

Finally, the systematic procedure for cost-benefit prioritization produces a priority for every program under consideration. This differs markedly from the committee recommendation procedure in that the committee recommendation specifies the programs that are to be funded and those that are not. The committee may start with a list of priorities in order to reach this recommendation, but the priorities are usually lost in the bargaining process. Since the fiscal constraint is very dynamic throughout the POM and Budget period, an established set of priorities provides a much more efficient basis for adjusting the POM as the constraint changes and for responding to "what-if" drills.

Certain perceptual and technical hurdles must be passed if this methodology is to be introduced into an organization successfully. The first hurdle is always the perception that a cost-benefit analysis will show the inexpensive, low-benefit programs to have highest priority and the expensive, high-benefit programs to have lowest priority. This only happens if the variance in the relative costs of the programs is greater than the variance in the relative benefits. The low variance in relative benefit is a definite characteristic of all initial benefit scales produced by the proponents. However, a skillful decision analyst will elicit sound benefit judgments on successive iterations of the benefit scale and thereby dispel the above-mentioned perception. The final list of priorities, then, will exhibit a mix of expensive and inexpensive programs at both top and bottom.

Two other areas related to the technical acceptability of the analysis affect the usefulness of the analysis. The first area is life-cycle cost estimates for the programs being considered. Obtaining good life-cycle cost estimates is a difficult problem to overcome because the only cost information typically available is for the five POM years. The second area is program definition; that is, programs must be defined in such a way that their contributions to the organization are independent. Although dependency between programs does occur occasionally, the functional viewpoints of the proponents ensures that program definition is not a major problem. However, in each application we have found that dependency between programs was a problem that could be solved by combining or redefining them.

Lastly, political problems have been encountered with a few proponents during the introduction of cost-benefit analysis. Some proponents felt that their programs would have been more favorably received if this new technique were not being used. Initially, all the proponents shared this suspicion; however, in the end, almost all agreed that their programs received more equitable consideration with the cost-benefit procedure. The few unhappy proponents had all done a poor job of educating the cross-sponsor group about the benefits of their programs. In the most extreme example, the proponent relied upon general policy statements to justify the importance of his programs. He did not adequately describe the difference between having and not having the programs; nor did he discuss the advantages of the particular program over possible alternatives. Naturally, the most articulate proponents have an advantage, but this characteristic of real-world decision-making will be with us until humans are replaced by computers.

We recommend that this procedure (modified as necessary) be incorporated into the organizational structure of the

services as well as other organizations in both the public and private sectors to prioritize their programs for funding. For the many reasons cited in this report, a better product results with this systematic, explicit procedure for allocating resources.

REFERENCES

1. Buede, Dennis M. and Peterson, Cameron R. An Application of Cost-Benefit Analysis to the USMC Program Objectives Memorandum. Technical Report TR 77-8-72. McLean, Virginia: Decisions and Designs, Incorporated, November 1977.
2. Buede, Dennis M.; Donnell, Michael L.; Ragland, Janice E.; and Rapp, Edward, G. Application of Decision Analysis to the U.S. Army Affordability Study. Technical Report TR 78-10-72. McLean, Virginia: Decisions and Designs, Incorporated,

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