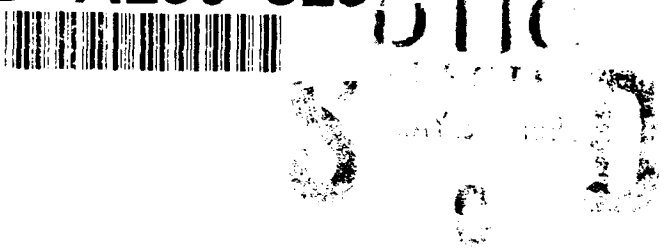

Estimating the Costs of Changes in the Active/Reserve Balance

Glenn A. Gotz, Michael G. Shanley,
Robert A. Butler, Barry Fishman

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Management of the total military force requires a determination of the proper role of the Selected Reserve. Both the executive and legislative branches of the government have increasingly looked to an expansion of the reserves as a potentially cost-effective way of maintaining the capability requirements of the total force. This trend has created the need for a cost methodology capable of supporting active/reserve force-mix decisions. This report presents a methodology for assessing the cost consequences of changing the mix of active and reserve units in the total force. The authors argue that the key to the usefulness of active/reserve force structure cost studies lies in a proper specification of the problem. Toward that end, they developed a structured accounting methodology for identifying and costing the resource, activity, and mission consequences of force structure change. (See also R-3748/1.) 45 pp. Bibliog.

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Estimating the Costs of Changes in the Active/Reserve Balance

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PREFACE

This report presents a methodology for assessing the cost consequences of altering the mix of active and reserve units in the total force. To accurately assess those consequences, a systematic, structured accounting system has been developed that translates simply worded force-mix questions into fully developed problem definitions. The essence of the methodology consists of a procedure for documenting the resource, activity, and mission changes attendant to alterations in the active/reserve force mix. Once properly documented and defined, the calculation of a full set of costs follows from the application of a generic active/reserve cost model.

The research is supported by two separately published companion reports. *Cost Element Handbook for Estimating Active and Reserve Costs* (R-3748/1-FMP/PA&E/JCS) is a reference handbook of detailed information useful for estimating the various elements of cost associated with force structure change; *Active/Reserve Cost Methodology: Case Studies* (R-3748/2-FMP/PA&E) employs case studies from the Air Force, Army, and Navy to demonstrate and further extend the methodology developed here.

This research is part of a broader agenda of cost and resource analysis studies conducted within the Defense Manpower Research Center. In constructing the cost model described above, the authors drew upon previously completed analyses of active and reserve unit costs, including *Unit Cost Analysis: Annual Recurring Operating and Support Cost Methodology*, R-3210-RA, March 1986; and *Cost Analysis of Reserve Force Change: Non-Recurring Costs and Secondary Cost Effects*, R-3492-RA, May 1987. As part of this body of work, a prototype system automating the methodology has been designed. Also, the cost factors reported here may soon be improved upon as a result of a current RAND review of the methodologies used to develop all DoD cost and resource factors.

This research was sponsored by the Assistant Secretary of Defense (Force Management and Personnel), the Assistant Secretary of Defense (Program Analysis and Evaluation), and the J-1 Directorate of the Joint Staff. The research was conducted by the Defense Manpower Research Center in RAND's National Defense Research Institute, an OSD-sponsored federally funded research and development center.

SUMMARY

Management of the total force requires a determination of the proper role of the Selected Reserve. Both the executive and legislative branches of the government have increasingly looked to an expansion of the reserves as a potentially cost-effective way of maintaining the capability requirements of the total force. This trend toward a greater dependency on the reserves has created the need for a cost methodology capable of supporting active/reserve force-mix decisions.

This report argues that the key to the usefulness of active/reserve force structure cost studies lies in a proper specification of the problem. Toward that end, we have developed a structured accounting methodology for identifying and costing the resource, activity, and mission consequences of force structure change.[1] Employing the methodology requires some knowledge of how decisions will be implemented. In the absence of required information, the cost analyst must either predict how decisions will be implemented or estimate the costs of alternative implementation scenarios. In either case, we believe that the methodology promotes accuracy in active/reserve cost studies, and facilitates the incorporation of cost analyses into national defense policy determinations.

COSTING PRINCIPLES

The cost consequences of force structure change depend on how that change will be implemented. For example, if a newly established military unit is located in existing facilities and uses personnel and equipment drawn from other parts of the force, that addition to the force structure may have little effect on system-wide costs. Alternatively, if the same unit requires a net increase in the number of military personnel, the procurement of additional equipment, and new military construction, its establishment may add considerably to DoD costs. As a result, a proper methodology for force structure costing requires recognition of several basic principles:

[1]The methodology assumes that the changes referred to are small in terms of the overall force structure, ones that do not significantly affect the cost of overhead functions. However, the same principles could be employed to develop a methodology that supports larger force structure changes.

- Whereas force structure problems are, by their very nature, usually expressed in the rather broad terms of military units, accurate costing requires a focus at a more detailed level of resources and activities.
- A complete cost analysis of active/reserve changes requires a precise definition of the full problem, including a specification of changes in peacetime function, wartime mission, manpower, equipment, and basing.
- The cost analysis of force structure changes should focus on *changes* in resources (and costs), not on total unit resources (and costs).
- Assessing the full consequences of active/reserve force structure changes often requires an extension of the analysis beyond the units directly targeted for change.
- In calculating a complete set of costs, the analyst should consider not only the change in annual operating and support costs, but also the nonrecurring (transition) costs of moving from the old force structure to the new one.
- A cost-support system for force-mix decisions should support the kind of "what if" analysis that facilitates the exploration of uncertainty and the clarification of cost tradeoffs.

AN ACCOUNTING STRUCTURE FOR CAPTURING CHANGES IN FORCE MIX

To apply these principles, this report develops a detailed and comprehensive accounting structure for describing net changes in DoD resources, activities, and missions that accompany changes in the active/reserve force mix. The centerpiece of the accounting system is the "unit transaction balance sheet," a tool for calculating the net effects of such decisions in the five basic categories of unit change: wartime mission, peacetime function, manpower, equipment, and basing.[2] For purposes of this report, these terms are defined as follows:

Wartime mission: the set of wartime activities that the unit is required to perform, and the unit's capability in conducting those missions.

Peacetime function: the set of activities performed by the unit in peacetime. The activities include both the organic functions of the unit that are performed exclusively for the benefit of the unit itself, and external functions that serve other parts of the force.

[2]Although each of these categories is distinct, they are clearly interrelated. For example, changes in unit mission often have direct consequences for manpower, equipment, and basing.

Manpower: the number and type of personnel that comprise the unit, distinguishing, at a minimum, between active and reserve, full-time and part-time, military and civilian, and officer and enlisted.[3]

Equipment: the unit equipment inventory, including major weapon systems, ground support equipment (aviation units only), maintenance support and test equipment, training equipment, other major end items of equipment (e.g., trucks), the initial stock of spare parts, and the initial munition requirements.

Basing: characteristics of the unit's location, including the facilities required by the unit to perform its mission and the land on which the unit is located.

The unit change categories constitute a complete description of the unit from both an input and output point of view. Manpower, equipment, and basing are units of input, whereas the wartime mission is an output. The peacetime function can be considered both.[4] Measures of both inputs and outputs are required because cost changes must ultimately be measured against changes in capability. Although this report's primary focus is on the measurement of costs, we believe that by specifically addressing changes in war and peacetime missions, a comparison of costs and capabilities is facilitated.

To calculate the *net effect* of a force structure change on each unit change category, the unit transaction balance sheet uses five transaction categories: two that add or subtract items, two that offset those changes, and one that calculates the net effect. Basic to the use of these categories is the distinction between "target" units and "other" units. Target units are the direct objects of a proposed force structure change, whereas the remaining units are those that are only indirectly affected. For example, a "target" unit would be a battalion specifically identified for deactivation, whereas "other" units are those that receive its manpower and equipment.[5] The five transaction categories can be defined as follows:

Resource addition to target unit: the addition of resources, activities, or missions to a target unit.

Resource subtraction to target unit: the subtraction of resources, activities, or missions from a target unit.

---

[3]Other distinctions that could prove important include job classification, grade level, and years of service.

[4]The operating tempo (OPTEMPO) of a unit applies to outputs because it is used as an indicator of unit capability. OPTEMPO can also be considered an input because it measures the rate at which resources (inputs) are consumed (e.g., POL per flying hour).

[5]The distinction between "target" and "other" units is especially useful when it is not possible to specify exactly what parts of the force are affected by a force structure change—for example, when the personnel of a deactivated unit are reassigned throughout many units in the remaining force structure.

Transfer from or to other units: the addition or subtraction of resources, activities, or missions within nontarget units.

Transfer from or to excess capacity: the addition or subtraction of equipment or real property within the inventory of idle or excess resources.

Net change: the change in resources, activities, or missions on a DoD-wide basis, calculated as the sum of effects on target and nontarget units.

The particulars of unit transaction balance sheets can vary widely depending on the nature of the problem. Table S.1 shows one example, an analysis of the transfer of a small arms unit from the active Army to the Army Reserve. Since units do not actually transfer in our accounting structure, such a change is considered an addition of a reserve unit and a subtraction of an active unit. Changes in the reserve unit appear in the additions column, and changes to the active unit appear in the subtractions column. Offsetting changes in the rest of the force are shown in the next two columns, and the calculated net effects appear in the column to the far right. The details of Table S.1 are fully explained in the body of the report (see Sec. III). Additional examples are published separately in a companion research report.[6]

THE CALCULATION OF COSTS

After a proposed force structure change has been specified in terms of net changes in resources and activities (e.g., as in Table S.1), a cost model can translate them into appropriate elements of cost. This report describes how the analyst can tailor a generic cost model to specific force structure problems.[7] To construct the model, we employ six cost-driving factors (operating tempo, manning amount, manning type, equipment amount, equipment type, and basing) and 15 basic elements of cost. The cost elements are separated into personnel-related and equipment-related categories, and further subdivided into

[6]See *Active/Reserve Cost Methodology—Case Studies*, R-3748/2-FMP/PAE. The report employs three case studies, one each from the Air Force, Army, and Navy, to demonstrate and extend the basic methodology developed here.

[7]The model is published in the form of a cost handbook, *Cost Element Guide for Estimating Active and Reserve Costs*, R-3748/1-FMP/PAE-JCS. In addition to a general discussion of cost issues that arise in the context of changes in the active/reserve force mix, this companion document contains individual "data sheets" on each element of a comprehensive cost element structure, and on other resource and intermediate factors used in our active/reserve cost model. Each data sheet defines the factor, provides a generic cost-estimating equation for its computation in specific instances, describes the possible variances the analyst will need to take into account, and lists offices and reports as additional sources of information.

Table S.1

UNIT TRANSACTION BALANCE SHEET: EXAMPLE OF ARMY INFANTRY UNIT TRANSFER TO RESERVES

Type of Unit Transformation	Target Units: Additions	Target Units: Subtractions	Transfer from/to Other Units	Transfer from/to Excess Capacity	Net Change
Wartime mission					
Army reserve					
Infantry unit	+				+
Army infantry unit		−			−
Antitank role		−			−
Reconnaissance role	+				+
Peacetime function					
Field training					
Active		−30 hr/wk			−30 hr/wk
Reserve	6 hr/wk				6 hr/wk
Recruiting duty	16 hr/wk				16 hr/wk
Post guard duty		−240 hr/wk	80 hr/wk		−160 hr/wk
Manpower					
Active					
Officer		−9	9		0
Enlisted		−243	243		0
Reserve					
Officer	9				9
Enlisted	212				212
Civilian	12				12
Equipment					
Light vehicles	50	−20			30
Rifles	20	−4			16
Reconnaissance optical units	40				40
TOW missiles	10	−160	80	70	0
Basing					
Barracks					
Occupied facilities		−40,000 sq ft			−40,000 sq ft
Idle facilities				40,000 sq ft	40,000 sq ft
Office construction	5,000 sq ft				5,000 sq ft

nonrecurring (investment) and annually recurring (O&S) classes. Further, equipment cost elements are distinguished so that the structure can apply to all the Services and to most weapon systems.

CONCLUSIONS

We believe that our structure for analyzing active/reserve force structure changes has several advantages. First, the methodology promotes accuracy in cost analysis because it directly addresses the three most common pitfalls of force structure costing: omitting indirectly affected units, ignoring critical cost elements, and incorrectly calculating the *net* effects of a change. Our focus on resources, activities, and missions, as well as our structured approach to calculating net effects, fosters a more precise calculation of the most relevant number in force structure decision analyses—*the change in total system costs*.

Second, we believe the costing approach can improve decisionmaking. On the one hand, complete documentation of changes in resources, activities, and missions will help ensure that conclusions about cost are placed in the appropriate context. On the other hand, linking costs to underlying changes will facilitate the identification and investigation of cost tradeoffs, making it possible to ask informed "what if" questions. The result will be an increased capability for incorporating cost considerations in the decisionmaking process.

In addition to these primary benefits, we believe the costing methodology has beneficial side effects. First, the application of the methodology will facilitate identification of valuable new alternatives. For the decisionmaker, the process of carefully and explicitly specifying a decision will naturally lead to ideas about alternative methods of implementation. For the cost analyst, unresolved ambiguity about how a change will be implemented will naturally lead to the creation of cases that explore the consequences of alternative resolutions of that ambiguity.

Second, the procedure will facilitate an integration of cost with capability issues. By making all resource changes transparent and by specifically addressing changes in war and peacetime missions, capability effects will more easily be addressed, the tendency to generalize from costs alone will be checked, and the integration of quantitative analysis with experience, judgment, and intuition will be facilitated.

To make the active/reserve cost methodology more accessible to cost analysts, RAND plans to recast the problem definition phase of the work in the form of a step-by-step guide to the execution of a cost analysis. Further, to accommodate the increased detail required to

implement the methodology. RAND is conducting additional research directed toward the automation of the procedure. Creation of a computer environment will promote the economic viability and practicality of the current methodology, and will increase the flexibility of cost analysts in examining a wide range of cost issues and decision alternatives within a given research budget.

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This report benefited from the detailed comments and criticisms of John Morgan and his staff in the Force Structure and Support Cost Analysis Division, Office of the Assistant Secretary of Defense for Program Analysis and Evaluation. Deborah Clay-Mendez, Office of the Assistant Secretary of Defense for Program Analysis and Evaluation, and Sue Bodilly and John Schank of RAND provided many useful comments and criticisms. RAND colleagues Gary Mills and Bridger Mitchell formally reviewed an early draft of the report; in addition to comments that improved the substantive content of the manuscript, their questions and suggestions improved its organization.

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CONTENTS

TABLES

I. INTRODUCTION

To achieve their objective of maintaining the capability requirements of the total force in a cost-effective way, both the executive and legislative branches of government have increasingly looked to the possible expansion of the role of the reserve forces.[1] To investigate that issue, numerous cost studies by the services and independent agencies have examined the relative costs of active and reserve units.[2] Further, both the Department of Defense and the services have invested in the improvement of data factors and elements used in those studies.[3]

Improving the accuracy of individual cost factors is valuable. This report, however, argues that the key to improving the usefulness of cost estimates and studies lies in a systematic, structured approach to determining the underlying resource, activity, and mission changes associated with active/reserve force structure decisions. Without such an approach, we believe that active/reserve cost studies may fail to adequately inform the decision process, which could in turn lead to inappropriate force-mix decisions. Useful cost support for decisionmaking requires a carefully detailed specification of the problem at hand, including a clear identification of all resource changes and important assumptions. Only then can cost analyses be incorporated into national defense policy determinations.

This research provides a method for assessing the estimating cost consequences of altering the mix of active and reserve units in the total force. A distinguishing feature of this method lies in its intended design: it is not a *budgeting* tool; it is a cost-analysis tool. Because its purpose is to analyze the costs of decisions, the method is designed to identify *changes* in costs. Moreover, while the methodology deals with the quantitative measurement only of costs, it also addresses the identification of changes in capability. Finally, the methodology focuses on changes in *total system costs*, not just the costs of isolated units.

Section II describes a series of potential problems that can arise in the process of estimating the costs of changes in the active/reserve force mix. The problems are illustrated with examples using published

[1]The words "reserves" and "reserve forces" in this report refer to the Selected Reserve components.

[2]Section II reviews existing studies.

[3]For example, the Air Force regularly publishes the U.S. Air Force Cost and Planning Factors, AF Regulation 173-13. In addition, the Assistant Secretary of Defense for Reserve Affairs has recently invested in cost-estimating models that can be applied across all of the services. See Schank, Bodilly, and Pei, 1986.

cost results. By varying missing or hidden components of seemingly simple and straightforward (but potentially ambiguous) force-mix questions, we show that underdefined questions can not only lead to a wide variety of conclusions about cost; they can even justify contradictory decisions. Finally, we discuss the requirements of a useful costing methodology and examine the benefits of such a methodology.

Section III develops our recommended approach for redefining the force-mix decision in terms that are appropriate for cost analysis. Because it uses a structured approach to asking questions, it provides the cost analyst with an accounting system for clarifying the resource, activity, and mission changes attendant to any active/reserve force structure change. Although the contribution of this report is fundamental—providing a practical means for accurately defining the problem—it represents an innovation in cost handbooks.

Section IV describes our procedure for translating a well-defined force structure problem into documented cost results. The methodology involves the application of six primary cost-driving factors to the net resource and activity changes, as determined by the method described in Sec. III. The resulting calculations yield the total costs of a force structure decision that is divided into 13 recurring and nonrecurring categories of costs.

Finally, Sec. V summarizes the benefits of the new methodology and discusses our plans to enhance it.

II. THE COSTING PROBLEM

As the role of the reserves in the total force continues to evolve, the services will face a growing number of questions concerning the nature of that role. What types of units should be placed in the reserves? What wartime missions and peacetime functions should they serve? How should those units be manned and equipped?

Recent studies of active/reserve force structure changes have reported unit cost in a variety of contexts, but none have attempted (as this report does) to fully support the decision process.[1] In some cases, existing studies simply report the "bottom line" costs of final decisions, without analyzing the alternatives (see, for example, Department of the Navy, 1985). In other studies, cost analyses focus not on actual decisions, but on notional units, comparing the operating and support costs of similar[2] active and reserve operations (see Reserve Forces Policy Board, 1984). A few reports do contain a more complete analysis of real decisions, but do not attempt to generalize the methodology (for example, Barbour, 1985). Finally, two reports (Schank, Bodilly, and Pei, 1986; and Schank, Bodilly, and Barbour, 1987) make methodological contributions to the calculation of active and reserve costs; that work provides a partial basis for Sec. IV of this report. However, no study has addressed the central issue of this report: redefining force structure decisions in terms of the associated changes in resources, activities, and missions.

In evaluating the cost consequences of active/reserve force structure decisions, it is important that analysts avoid a number of potential problems that can arise in this area of research. These problems originate in the basic dichotomy that exists between how force structure questions are typically posed, and how changes actually occur. On the one hand, questions concerning the active/reserve force mix are usually expressed in rather broad "unit" terms. For example, a particular type of tank unit, aviation unit, or ship might be activated, deactivated, or modernized. However, cost research cannot easily be carried out at the "unit" level, because military units do not exist in isolation from the rest of the force. Thus, changes in the active/reserve balance must

[1]See References for a list of those studies.

[2]"Similarity" usually involves the assumptions that both active and reserve units are fully manned, that they operate identical equipment, that they operate their equipment according to the programmed operating tempo, and that they have responsibility for the same or similar wartime missions.

necessarily be assessed on the much more detailed level of resources, like manpower and equipment, and may have repercussions beyond the specific units targeted for change.

Below, we expand on the implications of these observations for cost research. First, we describe the possible pitfalls of analyzing underdefined force structure decisions. We then illustrate their importance with a series of examples drawn from published reports. Finally, we discuss the principles of an appropriate cost methodology for supporting active/reserve force-mix decisions.

POTENTIAL PROBLEMS WITH COST ANALYSES

The potential problems of active/reserve force-mix cost studies are of several types. In the following paragraphs we will discuss those types by comparing the characteristics of complete decision analyses with those of more limited unit-level analyses.

First, decision analyses require precise problem definitions, in which resource implications are clear and critical assumptions are explicit. In contrast, simple unit-level analyses often "hide" assumptions that are crucial to the final outcome. More important, those assumptions do not always apply in the context of actual decisions.

For example, consider the question of whether a mission currently performed by an active unit should be transferred to a reserve unit. One way of inquiring into the cost consequences of such a transfer would be to examine the annual recurring costs of comparable active and reserve units performing the function in question. Due in large part to the part-time manning of the reserve forces, that analysis would likely indicate a lower cost in the reserve unit.[3] However, in the context of an actual decision, such an analysis might be deceptive by itself, because it implicitly assumes that active endstrength will decrease so that the personnel savings can be realized. That assumption might not be true. Active endstrength reductions cannot be assumed, because they are often not part of active/reserve decisions. A complete analysis of the active/reserve decision would have to include a consideration of the expected actual change to active personnel resources.

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[3]Enough work of this type has been completed to warrant the generalization that the annually recurring costs of reserve units in the steady state are typically 20 to 90 percent of their active counterparts. For example, see various statements made in *An Overview of the U.S. Commitments and the Forces Available to Meet Them*, hearings before the Military Personnel and Compensation Subcommittee of the Committee on Armed Services, House of Representatives, Ninety-Eighth Congress, First Session, October 19 to November 17, 1983. See pages 216, 234-235, 317, 321.

Second, in any decision analysis, it is important that decision variables be fully explored, especially when the choice of their value can significantly affect the final results. However, when decision alternatives are costed in simple unit terms, important variables may be treated inappropriately as constants, outside the scope of the problem. Because the services often associate programmed factors with military units for their proper manning, equipment, and operation, those values can inappropriately be considered fixed parameters in active/reserve force-mix problems. In actual decisions, unit factors—concerning personnel composition, peacetime activity level, equipment, mission, and basing—can be assigned values that differ from the standard. This is important precisely because those factors tend to drive costs. Complete decision analyses should document and explore the cost consequences of variation in all relevant decision levers.

Third, force-mix cost studies should be careful to distinguish changes in force structure from changes in the level of services provided. Thinking of problems in terms of units can obscure the difference between the two, making the sources of cost changes difficult to identify.

Consider the example of the Military Airlift Command (MAC) C-141 fleet and the question of whether some of the squadrons should be transferred to the reserve forces. A simple comparison of costs would show considerable savings for squadrons under the reserves, in large part because of a reduced flying-hour program. An active Air Force C-141 squadron flies more hours than a reserve C-141 squadron in part because active units provide more lift services to other military components, beyond those strictly required for the training of their own crews. If *some* of these services are lost due to a transfer of units to the reserves, *all* cost differences should not be attributed to the active/reserve decision. Such a reduction could just as easily be accomplished by simply reducing the flying-hour program in the active force and leaving the reserve force unchanged. To attribute the entire savings to the force structure change would obscure the source of the cost change.

Finally, proper cost analysis requires costing of the *total* decision, not just the units immediately affected by the change. However, focusing on units instead of decisions can leave major components of the total costs unaddressed. For example, in practice, it is not uncommon for a unit deactivation to result in a compensating change in the operation of other units. To continue the C-141 example above, suppose that instead of losing the lift services of the deactivated units, the remaining active airlift squadrons increased their flying hours to maintain some or all of that peacetime lift mission. In that case, failure to

account for the cost changes outside the units immediately under study would ignore significant components of the total decision cost.

In summary, we have argued that an overly simplified approach to the cost analysis of active/reserve decisions can obscure cost tradeoffs, bury important assumptions, and produce incomplete analyses. As a result, cost findings could, at best, be difficult to use in the context of actual decision alternatives; and at worst, they could lead to inappropriate decisions. Below, we illustrate these points with quantitative analyses.

ILLUSTRATING THE PROBLEMS

Posing force-mix problems in terms of unit changes does not provide sufficient information for a decision analysis. Instead, the goal of the cost analyst should be to predict the costs of the resource and activity changes associated with decisions. That means that the analyst must either predict how the decision will actually be implemented or estimate the costs associated with alternative implementation scenarios.

Below, we illustrate that point with specific examples from published reports. An important conclusion that emerges from the examples is that an analysis of force structure change requires the costing of *decisions*, not *units*; the costs of actual decisions usually cannot be represented by simple comparisons of notional unit costs.

C-141 Transfer Example

Consider a proposed transfer of C-141 aircraft missions from the active Air Force to the Air Reserve Forces (ARF).[4] The force structure change calls for deactivating two active MAC/Associate C-141 squadrons and transferring the aircraft to two new "all-ARF" squadrons.[5] By itself, that statement of the decision is incomplete because it leaves important information about the transfer unspecified:

- Is the peacetime mission of the deactivated units given up, completed by the new reserve squadrons, or accomplished by other means?

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[4]See Barbour, 1985.

[5]C-141 squadrons in the active Air Force have already been partially converted to reserve manning due to past efforts to enhance the reserve role in the total force. Of the four aircrews for each plane, two are from MAC in the active Air Force; the other two are "Associate" aircrews from the ARF. Support personnel are divided—about 60 percent in the actives, 40 percent in the reserves.

- Is total active endstrength reduced by the number of personnel in the deactivated active units, or is it left unchanged?
- Is total reserve endstrength increased or left unchanged?
- Do the remaining active C-141 units adjust to the transfer? (For example, is unit composition altered?)

The cost of transferring the C-141 squadrons to the reserves cannot be calculated without answers to these questions.

Base Case: Comparing the Costs of Notional Active and Reserve Units. To begin the exploration of cost consequences, consider the average costs of notional active and reserve units. Table 2.1 compares the total annually recurring cost of two active (MAC/Associate) and two reserve C-141 squadrons, distinguishing personnel costs from equipment costs. This initial analysis suggests that considerable savings will result from a switch to the reserves. Eliminating the two MAC/Associate squadrons would potentially save over $210 million per year in the active forces. At the same time, operating the C-141s in the reserves would cost much less—only about $120 million per year. The part-time nature of the reserve personnel and the sharply reduced usage of the units' equipment would apparently lead to considerable savings in both personnel and aircraft-related expenditures, a net of $92.8 million per year (Table 2.1).

However, the simple comparison of notional unit costs may not capture all cost consequences of the decision. Table 2.1 fills in the possible missing elements of the decision, one by one, to show their effects on cost.

Case A: Do Reserve Forces Increase or Stay (about) the Same? If, instead of creating two new ARF squadrons, the transferring C-141s were used to modernize the aircraft of two existing C-130 reserve squadrons, much more than $92.8 million (the amount implied in Table 2.1) might be saved. The reserves would need to recruit only a small

Table 2.1

ANNUAL RECURRING OPERATING AND SUPPORT COSTS OF TWO C-141 SQUADRONS
($ Million)

Cost Category	MAC/Associate	ARF	Difference
Personnel	84.6	59.6	25.0
Aircraft	128.0	60.2	67.8
Total	212.6	119.8	92.8

number of new personnel, and the increased reserve flying costs for the C-141s would be largely offset by the elimination of flying costs for the C-130s. Although the total force would lose the capability of the retired aircraft, the advanced age of some of the replaced C-130 aircraft might minimize the loss.

Recalculating costs requires knowing the costs of C-130 units. Other studies have estimated the annual recurring Operating and Support (O&S) costs of C-130 squadrons at $28.8 million, or $57.6 for two.[6] Thus, instead of spending $119.8 million (as shown in Table 2.1) on two new squadrons, the reserves would need to increase expenditures by only $62.2 million (119.8 – 57.6).[7] The decision would then save $150.4 million (92.8 + 57.6) annually, or over 160 percent of the savings implied by Table 2.1.

Case B: What Is the Change in Peacetime Activity Levels? The decision costs represented in Table 2.1 imply a willingness to give up much of the peacetime mission (or function) of the two MAC/Associate squadrons. That mission goes beyond the training of unit members. It includes the training of C-5 and rated overhead pilots, and the provision of airlift services for the armed forces and other government agencies. If instead of eliminating those services, a conscious decision were made to maintain them, the extra training and lift functions provided by the two deactivated MAC/Associate squadrons would have to be accomplished by alternative means.

One possibility for maintaining peacetime activity levels calls for increasing the flying-hour programs of both the new reserve units and the remaining C-141 squadrons in the active fleet. However, those actions would eliminate much of the savings implied by the comparison of notional unit costs. In fact, we calculate that the transfer decision under that scenario would save about $20 million per year in O&S costs,[8] only a fraction of those shown in Table 2.1.[9]

Case C: Does the Composition of Remaining Active Units Stay the Same? Another way of adjusting for the loss in peacetime mission is to adjust the organization of the remaining active units. Since, under the

[6]See Table A.23, p. 73, in Schank, Bodilly, and Pei, 1986.

[7]For the purpose of this illustration we are ignoring the short term increase in costs due to transition training for the C-130 flight and maintenance crews.

[8]Barbour, 1985, p. 41, describes the full scenario in which the annual cost differential between an ARF squadron and a MAC/Associate squadron decreases to about 10 percent of the latter's cost. The "$20 million" is an approximation obtained by taking 10 percent of the MAC/Associate cost in Table 2.1, and rounding.

[9]There are, of course, other ways of replacing the peacetime airlift and training. Barbour explored a variety of these alternatives. The most expensive—using commercial carriers for the lift, and having C-5 pilots train in the more expensive C-5 aircraft—would eliminate all the savings and lead to an actual increase in costs due to the transfer.

associate program, active C-141 squadrons are already composed of nearly one-half reserve personnel, one could reorganize those units to accomplish a transfer of the aircraft. Four MAC/Associate squadrons could split into two all-active Air Force squadrons and two all-ARF squadrons. In effect, the associate concept for four active squadrons would be abandoned in order to form the basis for the two new all-reserve squadrons. The peacetime mission would not be altered, and start-up costs would likely be minimal.

Of course, one cannot expect to save much from a purely organizational change. In fact, the alternative would cost money, since the associate concept is more efficient than the new organization. As the existing split between MAC/Associate personnel is about 60 percent in the active and 40 percent in the reserves, the active forces would save money, while the reserves would incur cost. We estimate that the case nets out to a $6.8 million increase in costs to the total force.

Case D: Do Active Forces Decrease or Stay the Same? Implicit in our calculations so far is the assumption that total active endstrength will fall due to the transfer; that is how the personnel savings originate. But alternatively, suppose that no reduction in endstrength accompanies the decision to transfer the aircraft; that the freed active personnel are simply transferred to other units. If so, the transfer of aircraft increases total personnel force size, rather than holds it constant, and most of the personnel savings implied in Table 2.1 do not occur.[10]

In fact, if total force size increases, and appropriate adjustments for the peacetime mission are made as per Case B, the transfer decision will not only save no money, it will require $40.8 million *more* per year of the military budget. To make the calculations, we determined that almost three-quarters of the personnel costs for MAC/Associate squadrons reflect pay for active-duty members of the Air Force. Not counting those costs as savings and adjusting for changes in the peacetime mission yields a $40.8 million net increase in cost per year.[11]

[10] Although the personnel savings do not occur, it should be noted that the capability for *at least some units* in the active forces has increased because the same level of total force manning is available to accomplish one less mission. The next section will describe how to record such changes as part of a cost analysis.

[11] This alternative would be more complex if it involved the principle of "cost avoidance." Suppose that an important reason for the transfer of the C-141 mission to the reserve forces had been to save money by releasing active endstrength for other uses. If so, it may be appropriate to include, as an indirect savings of the decision, the monies not spent, for example, on new accessions or on the bonus program for existing personnel. The key question for the cost analyst is "What would have happened in the absence of the active/reserve change?" Only after that aspect of the base case is determined can the analyst properly calculate the cost consequences of the cost avoidance policy.

Given that other costs were truly avoided due to the force structure change, the $40.8 million figure calculated above would be reduced. However, it is important to note that the timing and amount of the savings would be different under the assumption of a direct decrease in active endstrength.

Summary of Cases A–D: Table 2.2 summarizes the consequences of the five alternative ways we considered of transferring two C-141 squadrons to the reserve forces. Each of the cases discussed above represents a row of the table. Across the top are the basic assumptions of the case—concerning the peacetime mission, active and reserve endstrengths, and unit composition. Cost changes are in the right-hand column. The cost consequences range from a reduction of $151 million per year to an increase of $41 million per year depending on the assumptions. Clearly, the base case (a simple comparison of the average costs of notional units) by itself provides limited information about the desirability of transferring the C-141 squadrons.[12]

Examples Involving Nonrecurring Costs

The specification of alternatives can mean going beyond notional units to details of the implementation. Where a unit will be based and the timing of the change are two factors that can significantly affect the costs of making the transition. When these costs are large enough to affect the decision under consideration, they must be analyzed as part of the decision process.

Table 2.2

COST IMPLICATIONS OF ALTERNATIVE WAYS OF TRANSFERRING C-141 AIRCRAFT TO THE RESERVE FORCES

	Assumptions								
	Peacetime Function		Active Endstrength		Reserve Endstrength		Unit Composition		
Case[a]	Reduce	Same	Reduce	Same	Same	Increase	Keep	Drop	Savings ($ Million)
A	X		X		X		X		151
Base	X		X			X	X		93
B		X	X			X	X		29
C		X	X[b]			X[b]		X	7
D		X		X		X[b]	X		41

[a]See text for description of case and basis of calculations.
[b]Changes here smaller than those in rest of column.

[12]Note that peacetime outputs and wartime capabilities vary among the cases presented in Table 2.2. However, although the cost analyst may not be able to balance these costs and outputs, he or she can and should display the cost alternatives in such a way that makes the variations in outputs apparent. This subject is addressed further in Sec. III.

Implementation costs are primarily the nonrecurring start-up costs of a particular decision—those incurred before a change reaches the steady-state. They include construction of facilities; procurement of support equipment, spare parts, munitions; and the acquisition and training of unit personnel.

Nonrecurring costs have a high degree of variability, depending on the specific type of change in the total force and the characteristics surrounding the change.[13] Specifically, nonrecurring costs tend to be higher when units and personnel are being added to the total force, when the basing location cannot provide existing facilities or a sharing of various logistic support assets, and when a high proportion of appropriate prior-service personnel cannot be obtained.

That nonrecurring costs can be large enough to affect a force-mix decision can be illustrated by the example of the Navy frigate (FFG-7). The FFG-7 unit has been estimated to save nearly $2 million for the reserves in annually recurring costs.[14] However, those savings could be completely overshadowed depending on where new units locate. For example, basing new FFG-7 reserve units at Long Beach, a large active base with excess facilities, would cost only about $11 million in construction costs for six ships, or less than $2 million per ship.[15] Since construction costs could be recouped by one year's savings in O&S costs, nonrecurring costs do not change the conclusion about cost savings determined by looking at annually recurring costs alone.

In contrast, locating two new FFG-7 units at Puget Sound, where no facilities currently exist, would cost $68 million in construction costs alone. An annual cost saving of $2 million per ship cannot overcome an initial outlay of $34 million per ship, even at very low discount rates. Accounting for the nonrecurring cost changes the former cost saving to a cost increase. Although considerations other than cost may justify locating the units at Puget Sound, the full consequences of that move are unclear without including investment costs in the analysis.

If the start-up of the reserve unit is not simultaneous with the deactivation of the active unit, the timing can significantly affect costs. If active units are kept operating so a mission is covered while replacement reserve units are building up and becoming fully trained, costs could again be significantly affected. For example, Kostiuk examined the transfer of a helicopter (CH-46E) mission to the Marine Corps

[13]See Schank, Bodilly, and Barbour, 1987.

[14]Department of the Navy, 1984, p. IV-4.

[15]See Schank, Bodilly, and Barbour, Table 1, p. 29.

Reserve.[16] He found that although annual O&S costs were $2.5 million less in the reserve unit, if the deactivation of the active unit were delayed three years after the start-up of the reserve unit, those savings were significantly reduced.

CALCULATING A COMPLETE SET OF COSTS

Solving the problem of underspecification requires recognition of several basic principles regarding the costing of active/reserve force-mix decisions. First, setting up the problem requires a careful definition of the *type of change* taking place, which may prove more difficult than it sounds. For example, the C-141 case described above was defined as a *transfer* from the active to the reserves. However, units do not actually transfer; instead, a new reserve unit may be created and an existing active unit deactivated, keeping the manpower separate. The distinction may appear obvious, but it has important cost consequences. Specifically, the manpower savings from switching to part-time reserve manning do not accrue unless active endstrength is reduced.

Second, the details of a proposed change are important because the costs associated with a particular unit in a particular context may differ significantly from the average cost of that type of unit. For example, units with the same label may or may not have the same actual personnel composition, equipment requirements, functional capabilities, or mission assignments as other units of the same type. For instance, a new unit at one location may share equipment with other units at the base, whereas the same type of unit at an isolated base may require a full complement of its own equipment.

Third, when comparing alternative force mixes, investment costs can sometimes overshadow annual O&S. These costs, also called nonrecurring costs, can include those directly connected to a primary unit (e.g., construction, equipment, recruiting, and training costs), as well as those outside a unit but logically associated with a force-mix change (e.g., base opening costs).

Fourth, proper specification requires recognition that the costs of a decision may extend beyond the units directly involved. In the C-141 example described above, deactivation of the active C-141 unit implied either a loss in peacetime mission or greater responsibility for other active and reserve units. If the latter, a complete consideration of the decision required a balancing of the costs of directly affected units with

[16]Kostiuk, 1984.

those of indirectly affected units. Such changes may not be apparent from a first examination of force structure change. However, most choices of reserve over active manning imply either some reduction in activity level or transfer of activities to other units.

Fifth, flexibility is a desirable characteristic of a cost-support system for force-mix decisions. Once a problem has been adequately set up, planners should be able to ask the kind of "what if" questions that clarify cost tradeoffs, explore areas of uncertainty, and address increasingly complex decisions without the expense of significant additional analytical resources.

Finally, a cost-support system needs to be economically viable. At least some of the incompleteness of past studies can be traced to limitations in time and budget. Increased comprehensiveness is always available at additional cost; the challenge is to attain the improvements within existing analysis budgets.

To employ these principles in practice, active/reserve cost studies can benefit from a structured approach to problem definition. Section III of this report provides a detailed and comprehensive accounting structure for cost analysts, one that systematically ties resource changes to force structure changes. The approach breaks down a proposed decision into component parts suitable for cost analysis. Because all resource changes must be accounted for, all affected units are immediately identified. For each unit involved in the decision, proposed changes in function, mission, manpower, equipment, and basing are then documented, so that all relevant cost categories can be identified. Further, applicable transition-cost categories are identified and included. Only when the problem has been fully defined in this way—when what is to be costed and what is to be held constant are clearly identified—are cost factors applied to arrive at a total decision cost. The process need not involve prohibitive time and cost; in fact, it is sufficiently structured to benefit from the efficiencies of computerization.[17]

[17]A follow-on project to our work here will automate (for selected units) the methodology for estimating the costs of changes in the active/reserve balance.

III. UNIT TRANSACTION ACCOUNTING

This section addresses the unit costing problem (as described in Sec. II) by developing a comprehensive accounting structure for recording the net changes in DoD resources, activities, and missions that accompany changes in the active/reserve force mix. Structuring the force-mix decision in this way lays the groundwork for accurate cost calculations, helps focus the costing effort, and places the final cost figures in their proper context.

The section begins with a description of the unit transaction accounting system, followed by an example to illustrate its use. Concluding comments suggest how the procedure should be approached in other contexts.

THE UNIT TRANSACTION ACCOUNTING SYSTEM

In the active/reserve context, units can change in a variety of ways. Such changes to the total force structure include the modernization of a primary weapon system, the transfer of a replaced weapon system to a different unit, and the disposal of an old weapon system.

The unit transaction accounting system provides a vehicle for documenting the force-wide changes in resources, activities, and missions that follow from a change in force structure. The centerpiece of the accounting system is the "unit transaction balance sheet" (Table 3.1), a two-way classification of unit change according to the basic ways that units are transformed and the types of transactions that can occur. To use the balance sheet, analysts record changes in mission, peacetime function, wartime mission, manpower, equipment, and basing for each unit involved in a force structure change, and then calculate the net effect[1] of those changes on the DoD.

Below, we define and discuss the terms used in the balance sheet. They include both the transaction types (listed at the top of Table 3.1) and unit change types.

[1]The table is called a "balance sheet" because the left side of the table (the first four columns) shows the details of changes, and the right side of the table (the last column) shows the net result.

Table 3.1

UNIT TRANSACTION BALANCE SHEET: GENERAL FORMAT

Type of Unit Transformation	Target Units: Additions	Target Units: Subtractions	Transfer from/to Other Units	Transfer from/to Excess Capacity	Net Change
Function					
Mission					
Equipment					
Manpower					
Basing					

Transaction Types

We identify five fundamental types of transactions: resource addition, resource subtraction, transfer from/to other units, transfer from/to idle capacity, and net change for the DoD. The logic behind this classification scheme is as follows:

Any unit transformation, no matter how complex, can be defined as a set of transactions involving resource (or activity or mission) additions and resource subtractions. However, in this accounting system we limit the use of the terms "resource addition" and "resource subtraction" to refer to changes in "primary" or "target" units—those specifically targeted and directly affected by the proposed decision.

Changes in other units—those indirectly affected by the change—are captured using two other transaction categories: "transfer from/to other units" and "transfer from/to excess capacity." Combined with the first two categories, they capture the total effect of changes on the DoD. The final category, "net change," can be defined as the sum of all changes that occur in the directly and indirectly affected units. A formal definition of each of the five transaction categories appears in Table 3.2.

Transaction categories that involve other units and excess capacity are necessary because not all resource changes in a unit represent resource changes within the DoD. For example, in the formation of a new unit, if people and equipment are drawn from existing units and unused barracks on existing bases are available, the force structure change may have little effect on the DoD's demand for resources. Consequently, it may add relatively little to DoD costs. Alternatively, if

Table 3.2

DEFINITION OF TRANSACTION TYPES

Transaction Category	Definition
Resource addition	Addition of resources, activities, or missions to a target unit. Resource addition can occur in the creation of an entirely new unit, the replacement of the prime weapon system within an existing unit, or with the addition of resources or activities to an existing unit.
Resource subtraction	Subtraction of resources, activities, or missions from a target unit. Resource subtractions can occur in the disestablishment of a unit, the replacement of the prime weapon system within a unit, or with the subtraction of resources or activities from an exsisting unit.
Transfer from/to other units	Addition or subtraction of resources, activities, or missions to or from indirectly affected units as the result of a change in a target unit. Transfers occur when changes in target units do not reflect changes in the DoD as a whole.
Transfer from/to excess capacity	Addition or subtraction of equipment or real property from the inventory of excess resources that occurs as the result of a change to a target unit. Again, the transfers occur because changes in target units do not necessarily reflect changes to the DoD as a whole.
Net change	Resources or activities added to or subtracted from the total DoD pool, the bottom line of a resource transaction (and the number of greatest interest from a cost point of view). The net change for a resource can be calculated by totaling the changes in the other four transaction categories.

additional personnel must be accessed, a full set of equipment procured, and significant military construction approved for the change, the establishment of the new unit may add considerably to DoD resources and, consequently, to the costs of that decision.

The distinction between "target" and "other" units is useful especially when it is impossible to exactly specify other units that might be indirectly affected by a force structure change. For example, the manpower change associated with disestablishing an active unit may involve transferring personnel to a large number of other active units. Instead of listing each unit separately, the units are all grouped under the "other" category.

To determine whether units are indirectly affected by a force structure change, the analyst will need to ask about the source and disposition of resources in targeted units. If resources are added, what is their source? If resources leave, what is their destination or disposition? For example, when analyzing the disestablishment of a unit, the cost analyst must determine not only which unit resources leave, but also their disposition: Will they be transferred to other units (active or reserve), placed in an inactive status, or taken out of the inventory altogether? Only in the latter case does the change in the targeted unit represent a net change for the DoD.

Types of Unit Change

In addition to the classification of resource transactions, we need a taxonomy of changes to units that can arise in the context of those transactions. Without the ability to classify unit changes and to measure how units can change, we would be led to incorrectly assume that all units of a particular type change in the same way. The problems associated with such an assumption are discussed in Sec. II of this report. In fact, units can change in many different ways, each with varying resource (and cost) implications for the DoD.

We have identified five interrelated classes of unit change: changes in peacetime function, wartime mission, manpower, equipment, and basing. All consequences of force structure modification can be captured under these headings. Below, we define the classifications and discuss their importance in force structure costing.

Peacetime Function. The unit function, often referred to as the peacetime mission,[2] is simply the set of activities a unit performs in peacetime. A unit function change (in the context of a force structure change) consists of the addition of a function for a new unit, or the alteration or elimination of a function for an existing unit. The change can often be expressed in terms of the operating tempo (OPTEMPO) of unit equipment, for example, flying hours per aircraft or miles driven per tank. To provide the basis for accurate costing, all changes in unit function should be recorded in the Unit Transaction Balance Sheet.

Since a large part of a unit's O&S costs is derived from its day-to-day functions, alterations in unit function are likely to result in significant changes to recurring O&S costs, especially those that are equipment related. A large portion of the potential cost savings available

[2]A unit's peacetime mission is related to but not the same as its wartime mission. A unit can undergo changes in its day-to-day peacetime activities without an alteration in its capacity to perform in wartime. This is true because some of a unit's peacetime activities may be completely unrelated to its wartime mission.

from transferring missions to the reserves derives from the reduced OPTEMPO of reserve units as compared with active units.

Unit functions may be classified into two types: internal and external. Internal (or organic) functions are those performed exclusively for the benefit of the unit itself, such as the unit training and equipment maintenance of combat units. In contrast, external functions are those that to some degree serve other parts of the total force. The lift mission of cargo aircraft (as in the C-141 example discussed in the previous section) provides one example of an external function. Other examples might include a unit's provision of transportation and drayage services, construction, or medical services. At times, all activities of a unit may be considered external, as in the case of maintenance units that support combat units in the Army.

Identification of external unit functions is potentially important to the establishment of the scope of the cost problem. For example, in the case of a unit deactivation, the cost analyst would have to determine if services provided by the unit's external functions will be picked up in the workload of other units. If so, the analyst may need to expand the costing problem to include the effect of the deactivation on those other units.[3]

The analyst should, however, be aware of when the distinction between internal and external functions will play a significant role in the cost analysis. In general, we would expect support units to have more significant external functions than do combat units. Further, their presence is most likely to have significant cost effects when equipment-related expenditures are large in relation to personnel expenditures, as is the case in aviation units. Finally, external functions, no matter how significant to the unit, affect the cost problem only if they change as a result of the proposed decision. Otherwise, their costs are considered "sunk" for purposes of the cost problem, and can be ignored in the analysis.

Mission. Formally, the unit mission is the set of wartime activities that the unit is expected to conduct. For example, the C-141 squadrons discussed in Sec. II have a cargo-handling mission in wartime, as distinct from the fighting or strategic missions of other aircraft squadrons. In the context of a change in the force mix, unit mission changes are the alteration of a unit's capacity to perform in wartime, either

[3]Indirect effects of force structure changes are sometimes difficult to determine because they are partially governed by a future choice. For example, the C-141 example in Sec. II suggested that the decision on the flying-hour program of the remaining C-141 squadrons may come long after the decision has been made to transfer the targeted squadron to the reserves. In such instances of uncertainty, the cost analyst may have to cost alternative implementation scenarios.

because of a formal change in a unit's mission statement, or because of a change in a unit's capability in performing a given mission.

Changes in unit mission do not generate cost consequences in themselves; rather it is the changes in manning, equipment, facilities, and training exercises that follow from the mission change that generate the costs.[4] Nonetheless, when analyzing the cost consequences of a force structure change, it is important to document a change in mission in the unit transaction balance sheet (Table 3.1), for two reasons. First, if some aspect of a unit mission has been transferred to another unit, properly recording the change will allow the addition of that other unit to the scope of the cost problem. Second, recording changes in unit mission helps to place cost results in their proper context. For example, in the least costly alternative of the C-141 case considered in Sec. II, it would be important to note that the low cost stems largely from the deletion of a C-130 mission in the modernized reserve unit, a decrease in capability that does not occur in the more expensive alternatives.

Manpower. Unit manpower refers to the number and type of personnel that constitute a unit. In the context of force structure costing, a change in unit manpower consists of the addition of personnel to form a new unit or the alteration of the manpower composition of an existing unit.[5] To provide a basis for the calculation of personnel-related costs, all changes in unit manpower should be recorded in the unit transaction balance sheet (Table 3.1).

Since a large part of a unit's operating and support cost is derived from personnel-related costs, alterations in unit personnel are likely to result in significant changes to O&S costs. At a minimum, the cost analyst will need to calculate the nonrecurring investment costs of moving, accessing, and training new personnel, and the recurring costs

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[4]The unit's complement of men and equipment, combined with specific training exercises, is designed to provide the capacity to perform a specific set of missions. Further, its buildings and facilities (e.g., runways, hangars, barracks) are designed to make training for that mission possible. When a unit's mission is changed, it will often require a matching change in the number of personnel and their skills, the type or quantity of equipment, the OPTEMPO of that equipment, and the basing to make the unit capable of carrying out its new mission. Thus, changes in unit mission can affect the unit's nonrecurring and recurring O&S costs, but only in an indirect way.

[5]Unit manpower is clearly related to unit mission and capability, since manpower requirements are designed to provide the capacity to perform a specific set of wartime missions. However, unit manning can change without a change in mission. For example, budget and other constraints can lead to changes in unit authorizations or actual assignments while manpower requirements remain the same. Conversely, mission capability can change without a change in manpower. For example, if a unit deactivates without a change in the endstrength limit, then overall mission capability for at least some of the remaining units has increased, because the same level of total force manning is available to accomplish fewer missions.

of pay, allowances, and replacement training. In fact, a large portion of the potential cost savings available from transferring missions to the reserves derives from the part-time nature of most reserve personnel and from the availability of reserve personnel who have received prior training while in the active forces.

To document the effect of a force structure decision on manpower, the analyst must first determine the level of detail that is best suited to the problem. As with other choices about appropriate levels of aggregation, that judgment should be based on the existence of, or the potential for, cost-factor differences that would significantly affect the outcomes of the cost analysis. At a minimum, the analyst should distinguish between the following categories of personnel: active and reserve, full-time and part-time, military and civilian, and officer and enlisted. Additional levels of detail, if necessary, can differentiate by pay grade or any level of military specialty deemed appropriate. For example, flight-rated personnel are often distinguished by the relatively high cost of their training.[6]

The analyst should be aware of the uniqueness of the manpower resource and how it affects the analysis of force structure change. First, personnel typically do not move from one component to another (as do, for example, equipment, spare parts, and facilities) when the mission transfers. This is the primary reason we say that units cannot transfer from an active component to the reserve. We consider instead a transfer between components as the establishment of a new unit and the disestablishment of another.

Second, manpower is a unique resource because the number of personnel and the overall composition of the force are governed by separately imposed endstrength limits for each military component. Thus, changes in unit manpower from a force structure change do not translate into net changes in the total force unless endstrength limits are similarly changed. If endstrength limits are not adjusted, the analyst should be aware that the effect of a force structure change, by definition, extends beyond the units immediately targeted for change, and that this fact must be incorporated into the analysis.

Finally, manpower is unique among resources in the timing constraints it imposes on the implementation of a force structure change. In particular, experienced military personnel cannot instantaneously be added or subtracted from the force. Thus, in the short run, the military personnel of a deactivating unit are transferred to other units rather than deleted from the force; and, if necessary, the reduction in personnel endstrength is achieved in some other way (e.g., through

[6]For a more complete discussion of the number and types of people that compose a unit, see the discussion in Sec. III of the companion research report, R-3748/1-FMP/PAE/JCS.

reduced recruiting). Similarly, new personnel required by a force structure change either take a number of years to "grow" into the appropriate positions or transfer in from existing units. In the next section, we will discuss the effect of these constraints on the cost of implementing a force structure change.

Equipment. The unit equipment inventory includes the major weapon system, ground support equipment (aviation units only), maintenance support and test equipment, training equipment, other major end items of equipment (e.g., trucks), an initial stock of spare parts, and the initial unit munition requirements.[7] In the context of a change in force structure, unit equipment change consists of the addition of equipment to a new or existing unit, or the transfer, sale, storage, or disposal of equipment from a deactivating or restructuring unit.

Changes in the equipment inventory that follow a force structure change require documentation in the unit transaction balance sheet (Table 3.1). The documentation exercise will serve a variety of functions. First, a list of new unit equipment will facilitate the calculation of the nonrecurring equipment costs of unit change. In the event of a unit deactivation or a reorganization of unit equipment, these costs may also include those involved with transfer, sale, storage, and disposal of equipment. Such costs would be included in the event they contributed significantly to the change in total system costs.

Second, although the procurement cost of the major weapon system is rarely involved in an active/reserve decision, documenting the source of that equipment (if a major weapon system is coming into the unit) or disposition (if such equipment is leaving the unit) will facilitate the establishment of a proper problem scope. For example, modernization of an existing unit's equipment can create a domino effect of force structure change, as the old equipment of one unit becomes the new equipment of another. In those cases, the analyst may have to consider changes in a large number of indirectly affected units to measure the consequences of a single unit's modernization.

Finally, the documentation of equipment changes resulting from a change in the force mix will alert the analyst to the possibility of a significant change in the recurring costs of unit equipment operation. This can occur because each type of equipment has its own associated operating and support costs, costs that can change dramatically when, for example, a unit undergoes modernization.

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[7] As with manpower, unit equipment levels are closely associated with unit mission. For example, in the Army, authorized equipment levels are defined for various Authorized Levels of Organization (ALOs), which are related to a unit's deployment schedule.

Basing. Unit basing refers to characteristics of unit location that affect cost, which include the facilities required by the unit in performing its peacetime mission and the land (base or fort) on which the unit is located. Facilities can include hangars, runways, docks, piers, maintenance facilities, administrative buildings, and support facilities. Support facilities can include supply facilities, POL storage facilities, mess halls, and commissaries. In the context of an alteration in force structure, a change in unit basing refers to the addition, subtraction, or alteration of facilities or land that support the unit. A change can be measured in terms of the number or size of an item, or, if no other descriptive information is available, its dollar cost. To facilitate the calculation of the cost consequences of a change in force structure, changes in unit basing require documentation in the unit transaction balance sheet (Table 3.1).

Unit basing changes can affect recurring costs (for example, new facilities will incur additional maintenance costs, and abandoned facilities may be placed in a caretaker status), but their major effect is likely to be on the nonrecurring costs of force structure change. When a new unit is created, it is almost inevitable that nonrecurring basing costs will be involved, perhaps including the construction of new facilities, the refurbishing or improving of existing facilities, or the rental or purchase of real estate. Deactivating a unit may also have nonrecurring cost consequences, especially if the base or fort on which the unit is located is to be closed; for example, approved construction improvements may be avoided due to the change.

The unit change categories constitute a complete description of the unit from both an input and output point of view. Manpower, equipment, and basing are units of input, while the wartime mission is an output. The peacetime function can be considered both.[8] Measures of both inputs and outputs are required because cost changes must ultimately be measured against changes in capability. This report's primary focus is on the measurement of costs, but we believe that a comparison of costs and capabilities is facilitated by specifically addressing changes in war and peacetime missions.

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[8]The OPTEMPO of a unit applies to outputs because it is used as an indicator of unit capability. OPTEMPO can also be considered an input because it measures the rate at which resources (inputs) are consumed (e.g., POL per flying hour).

AN EXAMPLE RESOURCE ANALYSIS

Having defined the terms of the unit transaction balance sheet, we now turn to an example that illustrates its use. Consider the case of a small infantry unit transferring from the active force to the Selected Reserve.[9] The transfer amounts to the subtraction of an active unit and the addition of a reserve unit. To begin the resource analysis, we designate the two directly affected units as the "target" units, then produce a separate balance sheet for each of the five unit transformation categories. For efficiency, we show the effects of the force structure change on both units in the same balance sheet. Additions under target units will refer to the new reserve unit, and the subtractions will refer to the disestablishing active unit. Offsetting changes in the rest of the force will appear in the two "Transfer" columns of the balance sheet, making it possible to determine the net effect of the transfer to the DoD.

Change in Peacetime Function

A unit function change consists of the alteration of a unit's normal work activities during peacetime. To determine how the transfer will alter the unit's normal work activities, the analyst should first identify all major classes of peacetime activities pursued by the target units. Suppose these include field training, guard duty, and recruiting duty. The active unit conducts field training for 30 unit-hours per week, and requires 240 man-hours of post guard duty. Deactivation of this unit would, of course, mean a subtraction of these activities. On the other hand, establishing a reserve unit adds unit functions. Suppose the new unit will perform an average of 6 unit-hours per week in field training and 16 man-hours per week in recruiting duty. These additions and subtractions of functions can be tabulated as shown in the first three columns of Table 3.3.

The next step in documenting function changes is to consider how they affect the total force (see the last three columns of Table 3.3). The first function in our example, "field training," virtually defines an infantry unit in peacetime. Its output is readiness, and it produces that output by keeping its equipment in working order and by training its personnel. On balance, the decision to transfer the infantry mission into the reserves reduces field training by 24 unit-hours per week. However, unit training cannot be listed on the same line and netted

[9]Here we have created a simple example to illustrate the basic concepts of the accounting system. R-3748/2-FMP/PAE demonstrates the use of the methodology in three case studies, one each from the Air Force, Army, and Navy.

Table 3.3

UNIT TRANSACTION BALANCE SHEET: PEACETIME FUNCTION EXAMPLE

Type of Unit Transformation	Target Units: Additions	Target Units: Subtractions	Transfer from/to Other Units	Transfer from/to Excess Capacity	Net Change
Unit function:					
Field training:					
Active unit		−30 unit-hr/wk			−30 unit-hr/wk
Reserve unit	6 unit-hr/wk				+6 unit-hr/wk
Post guard duty		−240 man-hr/wk	+80 man-hr/wk		−160 man-hr/wk
Recruiting duty	16 man-hr/wk				+16 man-hr/wk

out because in our example the nature of that training (and therefore its cost) is different in the two units.[10] (Just how unit training differs between the units will become clear when we discuss "unit mission" in the next section.) Thus, the "net change" column shows separately a loss of 30 unit-hours per week in the active unit, and a gain of 6 unit-hours per week in the reserve unit (Table 3.3).

The second function on the list, "post guard duty," is an external function because it is a service rendered to the post, not just the (active) unit. When the unit is transformed and moved, this service is also withdrawn. However, since these services are required by the other active units not involved in the transfer decision, the analyst must determine whether and how those services will be replaced. The balance sheet (Table 3.3) shows that of the 240 hours of guard duty provided by the active unit, only 80 hours are taken over by other active unit(s), leading to a reduction of 160 man-hours of labor in the active force and a loss of the services rendered (Table 3.3).[11] It is important to note that reduction not only to record any possible cost

[10]In general, resources and activities must be listed separately when their associated cost factors differ. Conversely, activities and resources may be combined in arithmetic operations if their associated costs are the same.

[11]In subtracting to obtain a "net change," we have assumed that the cost of the "other units" providing post guard duty will be the same as the cost of the primary active unit providing those services.

savings, but also to put the cost results into perspective—by documenting the nature of the services given up in order to make the change in force structure.

The last item on the list, "recruiting," has been explicitly added to the reserve unit's normal functions. Since the reserve unit is recruiting for itself, the 16 man-hours of recruiting duty per week are a net increase to the total force, and not a duty taken over from some other unit (see Table 3.3). The addition of this function may or may not add to the O&S costs of the unit.

Change in Mission

To catalogue unit mission changes, we proceed as we did with unit functions. The first step is to identify all unit missions that will be affected by the decision. In the infantry example we are considering, suppose the new reserve unit will retain the light-infantry mission of the active unit, but at a lower ALO level (implying that the reserve unit is expected to deploy later than the active unit). In addition, suppose the active unit had an antitank role that the reserve unit will not have; and that the reserve unit will acquire a reconnaissance mission not assigned to the active unit. These additions, subtractions, and changes in missions can be tabulated as shown in Table 3.4.

Since the purpose of this analysis is to describe rather than measure changes in mission, Table 3.4 uses the symbols "+" and "–" in place of actual quantities. The qualitative descriptions serve two purposes. First, clarification of the change in mission will help describe the output of the transfer decision—what the costs are paying for. Second, a list of mission changes will alert the analyst to possible interrelated effects on unit function, manning, and equipment. In our example, the

Table 3.4

UNIT TRANSACTION BALANCE SHEET: MISSION EXAMPLE

Type of Unit Information	Target Units: Additions	Target Units: Subtractions	Transfer from/to Other Units	Transfer from/to Excess Capacity	Net Change
Unit mission					
Light Infantry, ALO2	+				+
Light Infantry, ALO1		–			–
Antitank		–			–
Reconnaissance	+				+

change in mission will signal the need to differentiate between the active and reserve units when documenting the training function in Table 3.3.[12] Further, the changes will have implications for the unit Table of Organization and Equipment (TO&E) that the analyst will be interested in obtaining.

Change in Manpower

A net change calculation for manpower, developed for our hypothetical transfer of the small arms unit, is presented in Table 3.5. The table illustrates several points. First, manpower is not generally transferable between components; thus none of the manpower from the deactivating unit serves in the new reserve unit. Second, the size of the new reserve unit is smaller than the size of the existing active unit, partially a result of the lower ALO level of the reserve unit (see the mission comparison in Table 3.4). Third, in addition to the minimum level of required detail on personnel categories noted above, the table distinguishes personnel in four broad functional areas: operators (infantry and weapons personnel), maintenance personnel, administrators, and support personnel.[13] This categorization may be required to ensure that the analyst captures the full personnel implications of a change. Because of service differences in the ways that units are defined, all relevant personnel, especially in the maintenance and support area, may not be included in the primary unit manning document.[14]

In addition to showing what happens to manpower in the primary units, Table 3.5 shows how those changes affect the total force. Although one might expect little change in endstrength from the transfer of a mission out of active duty and into the reserve force, the implication of the balance sheet is that there is a significant net increase in DoD manpower. The increase occurs in the following way. All members of the reserve unit are new to the force; none came from

[12]Unit training must be differentiated by unit because the cost factors will differ. For example, instead of using expensive antitank munitions to maintain the required skills for the mission, the unit now operates a large number of small vehicles. Thus, the consumption of training ammunition will drop, and the operation and maintenance of vehicles will increase.

[13]In practice, the broad occupational groups shown in this illustration could be replaced by military occupation [Military Occupational Specialty (MOS), Air Force Specialty Code (AFSC), Rating], officer designator community, and civil service occupational code for greater accuracy. Alternatively, a detailed disaggregation could be dispensed with altogether, depending on the composition of the unit and the accuracy required by the situation.

[14]For a discussion of the appropriate range of personnel to be included in a cost analysis, see R-3748/1-FMP/PAE/JCS.

Table 3.5

UNIT TRANSACTION BALANCE SHEET: MANPOWER EXAMPLE

Type of Unit Transformation	Target Units: Additions	Target Units: Subtractions	Transfer from/to Other Units	Transfer from/to Excess Capacity	Net Change
Reserve unit:					
Military personnel					
Officer (full-time)	1				1
Officer (part-time)	8				8
Total officer	9				9
Enlisted (part-time)					
Infantry	150				150
Weapons	56				56
Administrative	2				2
Support	4				4
Total enlisted	212				212
Civilian personnel					
Maintenance	11				11
Support	1				1
Total civilian	12				12
Active unit:					
Total officer		−9	9		0
Enlisted					
Infantry		−153	153		0
Weapons		−58	58		0
Maintenance		−12	12		0
Administrative		−4	4		0
Support		−16	16		0
Total enlisted		−243	243		0

other units. However, at the same time we have assumed that no active personnel left the service as a result of the disestablishment of the unit. Instead, the active unit's personnel are assumed to have transferred to other active units. This is shown in the "transfer from/to other units" column, which simply repeats the data for the subtracted unit, and the "net change" column, which shows no change in active endstrength. Of course, this assumption has a large effect on the resource implications of the change. Instead of a slight decrease in the size of the total force (the active unit employs about 250 people, whereas the reserve unit employs about 230), the result is a large increase from the addition of the reserve unit.

In some situations, specifying the manpower consequences of a force-mix change can become more complex. For example, suppose that the active forces cut endstrength as a result of the transfer, but in the form of accessions rather than in trained personnel. Because of the difference in cost between trained and newly acquired personnel, the reduction in accessions would have to be handled separately. For example, one might think of the pool of accessions as a kind of target "unit" and record the savings under the subtractions column.

Other complexities can arise because of the multitude of ways that personnel can be added or subtracted from the force. For example, new personnel for a unit might be obtained almost immediately from the use of reenlistment bonus incentives, or the unit may take several years to "grow" from new recruits. If the cost implications are large enough, the analyst may want to add a time dimension to the manpower balance sheet to take into account the methods used for increasing or decreasing endstrength.

Change in Equipment

Table 3.6 shows the equipment requirements generated by the infantry example used in this section. It lists the specialized equipment that must be obtained for the reconnaissance mission of the new unit (e.g., more light vehicles, recoilless rifles, and optics) and the disposition of equipment that had been maintained for the antitank mission of the old unit. Personal weapons (small arms), the mess gear, and most other unit equipment are not included in the balance sheet because they are the same for both units.

Table 3.6

UNIT TRANSACTION BALANCE SHEET: EQUIPMENT EXAMPLE

Type of Unit Transformation	Target Units: Additions	Target Units: Subtractions	Transfer from/to Other Units	Transfer from/to Excess Capacity	Net Change
Unit equipment					
Light vehicles	50	−20			30
Recoilless rifles	20	−4			16
TOW missiles	10	−160	80	70	0
Reconnaissance optical units	40				40

Table 3.6 indicates areas in which purchase economies are possible. The light vehicles and recoilless rifles owned by the subtracted unit are transferred to the added unit, reducing the number that would otherwise have to be purchased. Although the new reserve unit requires 50 light vehicles, the purchase requirement is only 30, because 20 are available from the deactivating unit. Similarly, only 16 of the 20 required recoilless rifles have to be bought. On the other hand, no economies are possible in the case of the reconnaissance optical units—all of the 40 required are to be new equipment.

Besides specifying new equipment requirements, Table 3.6 shows the disposition of unneeded old equipment. Of the 160 TOW missiles in the disestablished active unit, only 10 can be used by the new reserve unit. However, the remaining missiles do not leave the DoD inventory. Rather, 80 TOW missiles are transferred to other active units with antitank missions, and the other 70 are added to the inactive inventory.

Additional complexities can arise in the equipment context, just as they did in the manpower context. For example, Table 3.6 shows that the force structure change had no effect on the number of TOW missiles in the DoD, implying no change in cost. This is consistent with the assumption that the unused missiles under "excess capacity" go to war reserve stocks, with no change in the total requirement. Suppose, however, that as a result of this action, there is a net decrease in the total TOW missile requirement, and that at the time of the next purchase, money would be saved. This effect might be captured by thinking of the system for procuring new missiles as a target "unit" and showing a decrease under the subtraction column.

Change in Basing

Table 3.7 is a unit transaction balance sheet for basing changes for our illustrative unit transfer. The reserve unit will be based at a different location from the active unit, but, to a large extent, it will be able to take advantage of existing facilities and land. The table records that the active unit's barracks at the old location (consisting of a total of 40,000 square feet) will be allowed to go vacant, and that 5000 square feet of construction will be necessary to install the reserve unit in its new home.

The barracks are listed twice in the table because their maintenance costs while idle differ from those costs while occupied. Had those cost factors been the same, the subtraction from the active unit and addition to excess capacity could have been listed on the same line, with a zero in the net change column.

Table 3.7

UNIT TRANSACTION BALANCE SHEET: BASING EXAMPLE

Type of Unit Transformation	Target Units (sq ft)		Transfer from/to Other Units	Transfer from/to Excess Capacity (sq ft)	Net Change (sq ft)
	Additions	Subtractions			
Unit basing					
Barracks					
Occupied facilities		−40,000			−40,000
Idle facilities				40,000	40,000
Meeting space construction	5,000				5,000

Clearly, this decision will involve more resources than if a "transfer in place" had occurred. On the other hand, the extra resources are modest when compared with an alternative that required significant new construction, as would, for example, the opening of a new base.

Summary of Net Resource Changes

There is now sufficient information to summarize the resource consequences of our proposed force structure change. Table 3.8 presents, in one table, the net resource changes associated with function, mission, manpower, equipment, and basing. The summary serves two purposes: First (as we will discuss in the next section), it will help tailor a cost model specific to the problem at hand, and thereby provide a valuable tool for the accurate and complete costing of force structure decisions. Second, it will describe the implications of the active/reserve change from both an input and output point of view, which will help place the ultimate cost figures into perspective. However, the cost analyst should keep in mind that, as illustrated below, summaries at more than one level of aggregation may be required to complete the analysis.

Table 3.9 presents a qualitative summary of changes in our illustrative transfer of an infantry unit. The table displays not only the net effect to the DoD by type of change (based on Tables 3.3 through 3.7), but also shows how those changes are distributed to the active component of the total force, the reserve component, and in the resources in excess capacity. This distribution provides additional insight into the final cost/savings of our exemplary force structure change. For example, the table shows not only that the reserve component has

Table 3.8

UNIT TRANSACTION BALANCE SHEET: EXAMPLE SUMMARY

Type of Unit Transformation	Target Units: Additions	Target Units: Subtractions	Transfer from/to Other Units	Transfer from/to Excess Capacity	Net Change
Wartime mission					
Army reserve Infantry unit, ALO2	+				+
Army infantry unit, ALO1		–			–
Antitank role		–			–
Reconnaissance role	+				+
Peacetime function					
Field training					
Active		−30 hr/wk			−30 hr/wk
Reserve	6 hr/wk				6 hr/wk
Recruiting duty	16 hr/wk				16 hr/wk
Post guard duty		−240 hr/wk	80 hr/wk		−160 hr/wk
Manpower					
Active					
Officer		−9	9		0
Enlisted		−243	243		0
Reserve					
Officer	9				9
Enlisted	212				212
Civilian	12				12
Equipment					
Light vehicles	50	−20			30
Rifles	20	−4			16
Reconnaissance optical units	40				40
TOW missiles	10	−160	80	70	0
Basing					
Barracks					
Occupied facilities		−40,000 sq ft			−40,000 sq ft
Idle facilities				40,000 sq ft	40,000 sq ft
Office construction	5,000 sq ft				5,000 sq ft

Table 3.9

QUALITATIVE SUMMARY OF NET CHANGES: EXAMPLE SUMMARY

Type of Unit Transformation	Active	Reserve	Excess Capacity	DoD
Mission	-	+	N/A	+,-
Function	-	+	N/A	-
Manpower	0	+	N/A	+
Equipment	-	+	+	+
Basing	-	+	+	+

SOURCE: Tables 3.2 through 3.6 "net change" columns.

increased its capacity (an obvious result given the nature of the change), but also that there are resources in excess capacity that can be drawn upon for future use (perhaps not so obvious a result). Further, although the active forces have a decreased mission and function (implied by the nature of the change), the active manpower has not changed, suggesting an increase in overall capability in the remaining active forces (because the same number of people are available to complete a reduced task).

CONCLUSION

The unit transaction accounting system translates proposed changes in force structure, typically defined in broad unit terms, into changes in underlying resources, activities, and missions. The first step in this process is to identify the set of units that is affected by the change. The second step is to catalogue all the changes each unit will undergo in mission, peacetime function, manpower, equipment, and basing. Doing so will often require that the analyst determine or make assumptions about how a change will be implemented. Finally, the analyst must determine whether changes in individual units represent net changes to the DoD, or whether those changes are offset by other changes in indirectly affected units. If the latter is true, effects on those other units must be incorporated into the analysis.

Because of the interrelatedness of the different aspects of unit change, it may be difficult to immediately identify all appropriate changes. Among units, there may at first be insufficient information to identify all units that are indirectly affected. Within units, it may not be possible to initially identify all unit function changes without first

having analyzed the consequences of a change in unit mission. Thus, the cost analyst will likely need to make the resource analysis an iterative process, adding and revising information with each successive iteration.

IV. COSTING PROCEDURE

This section outlines a costing procedure for translating the net changes in resources and activities, as determined in the balance sheets of Sec. III, into net changes in cost. A companion publication, R-3748/1-FMP/PAE/JCS, supports the details of the costing process. In contrast, this report describes how to effect a transition from the resource analysis to the cost analysis, and how to focus the costing effort. Specifically, it explains a method of efficiently allocating analysis resources by tailoring the general cost model to individual cost problems.

SUMMARY OF RESOURCE CHANGES

The first step in the cost analysis is to summarize aspects of the resource, activity, and mission analysis that generate cost. Continuing the example presented in Sec. III, Table 4.1 provides the required information in the context of a transfer of an Army unit to the Army Reserve. The information in the table will serve as an initial guide to the costing of that specific force structure change.

The table lists the types of changes generated by the move, a subset of the items in the unit transaction balance sheet (see Table 3.8). What is missing from Table 4.1 are those items that do not directly incur costs, such as changes in mission statements and some of the unit-level changes in resources (e.g., for TOW missiles) that turned out to have zero net effect on the DoD. What is included in Table 4.1 are cost-causing changes in resources and activities with a nonzero net effect, and unit-based changes which, although they involved no net change in resources, involved a transition cost. For example, although the active personnel transfers would not change endstrength, they would likely involve significant nonrecurring costs for transfer and retraining. For this reason, the transfers have been included in Table 4.1.

Most entries in the first column of Table 4.1, labeled "Basis for Estimate of Cost or Savings," are the same numbers from the "Net Change" column of the unit transaction balance sheet. The exceptions are the items listed that had a zero in the net change column. In those cases, the numbers that appear come from the internal sections of the balance sheets. For example, in Table 4.1, "Active Transfers" come from the additions column of the manpower balance sheet.

Table 4.1

CATALOGUE OF COST-CAUSING CHANGES

Type of Change	Basis for Estimate of Cost or Savings	Type of Cost	
		Nonrecurring	Recurring O&S
Peacetime function			
Field training			
Active	−30 hr/wk		X
Reserve	6 hr/wk		X
Recruiting duty	16 hr/wk		X
Post guard duty	−160 hr/wk		X
Manpower			
Active transfers			
Officer	9	X	
Enlisted	243	X	
Reserve			
Officer	9	X	X
Enlisted	212	X	X
Civilian	12		X
Equipment			
Light vehicles	30	X	X
Rifles	16	X	X
Reconnaissance optical units	40	X	X
Basing			
Barracks			
Occupied facilities	−40,000 sq ft	X	X
Idle facilities	40,000 sq ft		X
Office construction	5,000 sq ft	X	X

The resource and activity numbers of the first column form the basis of the calculation of net changes in cost. As a first step in that process, the two right-hand columns of Table 4.1 indicate which of two types of cost are potentially involved. The first type is nonrecurring costs, those required in the transition period to the new force structure. The second type is operating and support costs, those annually recurring costs required once the new force structure is in place.

The presence of an "X" in Table 4.1 represents a first approximation of how resource changes will affect recurring and nonrecurring costs. Not every type of change affects both recurring and nonrecurring costs. For example, additions or subtractions in peacetime function nearly always affect recurring costs, but they rarely affect

nonrecurring costs. Further, each "X" in the table does not necessarily indicate a relevant cost for every decision. For example, the O&S costs generated by the deletion of the guard duty and the addition of the recruiting duty may be small enough to be ignored in this problem. The presence of the "X", however, allows that to be a specific assumption.

DESIGN OF A TAILORED COST MODEL

Cost results are derived from resource and activity changes through the application of a cost model. Below we outline a general cost model for the calculation of active and reserve unit costs,[1] and show how it can be used to design a cost model tailored to apply to a wide variety of force structure problems.

The General Cost Model

In many cases, individual cost elements can be calculated simply by multiplying resource factors (such as those shown in Table 4.1) by the appropriate cost factors. For example, the annual pay and allowances of the new reserve officers in our transfer example could be calculated by multiplying the number of added officers (9 in Table 4.1) by the average cost per officer. However, a general active/reserve cost model, capable of supporting a wide range of force structure decisions must identify *all* appropriate elements of cost, and for each of those elements, it must determine the factors that drive cost.

Cost-Driving Factors

We have grouped the resource factors of active/reserve decisions into six categories that we call "cost-driving factors," to emphasize their relationship to costs:

- Changes in unit operating tempo
- Changes in manning quantity
- Changes in manning type
- Changes in equipment quantity
- Changes in equipment type
- Changes in unit basing

The cost-driving factors are closely connected with the balance sheets (Tables 3.3 through 3.8) in our example of the transfer of an

[1]This model is described more fully in R-3748/1-FMP/PAE/JCS.

Army mission. For example, the unit function balance sheet (Table 3.3) should tell the analyst whether "unit operating tempo" has been affected. Any nonzero entry in the net change column of that balance sheet indicates a difference in operational pace, which in turn can lead to changes in costs. In our example, the change in unit field training would reduce operating and support costs. The outcome of other function changes, however, are uncertain and may not be large enough to generate significant costs.

"Changes in manpower quantity" are a result of the endstrength policy adopted as a part of a decision. "Changes in equipment quantity" also will often be related to endstrength policy, because men and equipment are frequently combined in fixed proportions in units. In our example, we showed reserve endstrength gains and some equipment quantity changes.

"Changes in manning type" occur when the total number of personnel stays the same, but their characteristics change. Personnel characteristics that can influence costs include the component, skill involved, rank, grade, occupation, as well as air and sea rating. However, changes in manning type are likely to have less effect on cost than are changes in quantity. With changes in type, we would measure only the difference between the costs of the old manning structure versus those of the new one, a much smaller cost than that of entirely new personnel.

"Changes in unit basing" are identifiable from the unit basing balance sheet (Table 3.7). Nonzero entries in the net change or excess capacity columns indicate a likely change in cost. In our example, the construction of offices would lead to military construction costs, and the vacating of barracks would lead to the reduction of recurring building maintenance (but perhaps not their elimination, given the likelihood of caretaker costs) and the nonrecurring costs of shutting down the buildings. Many more costs would accrue if the move involved the construction of a new reserve base.

Resource/Cost Table

The six cost-driving factors defined above affect individual elements of cost, as described in Table 4.2, the resource/cost table. The table lists a complete cost-element structure for the calculation of active/reserve costs. It distinguishes among four types of nonrecurring investment costs and 11 types of recurring operating and support costs—four in the personnel area and seven in the equipment area.[2]

[2]For this illustration, the structure is somewhat abbreviated because it lists only equipment cost factors that are specific to the Army. Section I of R-3748/1-FMP/PAE/JCS gives a more complete structure, versatile enough to handle active/reserve changes in all the Services, and at varying levels of detail.

The six columns of Table 4.2 detail the relationship between cost drivers (listed across the top) and the cost elements to the left. In each row an "X" refers to a major cost driver for the element; that is, calculation of that element's cost will always involve that resource factor. The "+" indicates possible applicability, depending on the circumstances of a particular case. Thus, the "manning quantity" factor is always important in calculating the nonrecurring costs of personnel acquisition and training (hence the "X" in the first two rows), but only sometimes important in calculating construction costs, as, for example, when barracks are being constructed (hence the "+" in the fourth row).

Of course, to actually calculate the costs of a force structure decision using a cost model, many more particulars would be required than are currently provided in the resource/cost table. Many of those details can be found in the companion document, *Cost Element Handbook for Estimating Active and Reserve Costs*, R-3748/1-FMP/PAE/JCS. That report contains individual data sheets on each cost element in Table 4.2.[3] Each data sheet defines the cost element, provides a generic cost-estimating equation for its computation in certain instances, describes the possible variances the analyst will need to take into account, and lists offices and reports as additional sources of information.

Table 4.2 can also be viewed as a partial summary of the *Cost Element Handbook*. The presence of an "X" in a cost-element row of Table 4.2 means that the indicated resource factor is embedded in the "cost-estimating equation" on the data sheet for that cost element. The presence of a "+" indicates that the resource factor is described as possibly important elsewhere on the data sheet (usually in the "variances" section).

Tailoring a Cost Model

In practice, Table 4.2 can function as a planning tool for cost analysts engaged in the early stages of a study on a force structure decision. Having determined (even in a qualitative way) which of the cost-driving (resource) factors are important in a given situation, the cost analyst can use the table for the design of a model tailored to the case under study. The analyst begins by scanning down each of the columns of relevant changes and circling the "X" and "+" signs that potentially apply to the situation at hand.

Not all the entries in the table will apply in every case. Our infantry example involved changes in unit basing, so the analyst would read

[3]It also contains data sheets on other resource and intermediate factors used in the active/reserve cost model.

Table 4.2

RESOURCE/COST TABLE

Cost Element	Cost-Driving (Resource) Factor[a]					
		Manning		Equipment		
	OPTEMPO	Amount	Type	Amount	Type	Basing
Nonrecurring costs						
Personnel acquisition		X	X			X
Personnel training		X	X			X
Equipment procurement				X	X	+
Construction		+	+	+	+	+
Operating and Support costs						
Personnel costs						
Military pay and allowances	+	X	X			+
Civilian pay and allowances	+	X	X			+
Replacement acquisition and training		X	X			X
Support-related costs	+	X	+	+	+	+
Equipment costs[b]						
Petroleum, oil, lubricants (POL)	X			X	X	
Training munitions		X	X	X	X	
Maintenance material	+			X	X	
Replenishment spares	+			X	X	
Depot maintenance	+			X	X	
Higher-level maintenance	+		+	X	X	
Other	+	+	+	+		+

SOURCE: Table 1.3, R-3748/1-FMP/PAE/JCS

NOTES: X = Major cost driver required for estimation of cost element. + = Potentially important cost driver required for estimation of cost element in some cases.

[a]See text for definition of terms.

[b]These equipment cost elements are appropriate for Army units. The list differs somewhat for the other Services. See Table 1.3 in R-3748/1-FMP/PAE/JCS.

down the last column of Table 4.2, noting that the basing changes described in Table 3.7 would affect nonrecurring construction costs and the recurring and nonrecurring costs of personnel acquisition and training (because of the prior-service factor in the location of the unit). However, in our example, basing changes do not affect equipment procurement costs, so the "+" in that row would not be circled.

After the analyst has determined which elements of cost will be affected by which resource factors, an attempt is made to access the relative importance of each cost element in the problem. If possible, preliminary estimates for the cost elements are made, using material

from the *Cost Element Handbook*, Service cost-factor guides, or prior studies. During this process, the analyst should try to determine how much time and effort would be required to refine that estimate and produce a more accurate figure. The point of this assessment is to help focus the remaining analysis on elements of cost that have the greatest potential effect on the outcome. This focus can be achieved by rank ordering the cost elements according to their importance to the analyses. Depending on the desired degree of accuracy, the cost analyst will likely be able to rule out the need for refining the cost estimates for most of the elements, because even sizable percentage changes in their values would not produce significant changes in the total cost estimate for the force structure change. Among the remaining individual cost elements, the probability that the cost estimate will change significantly and the estimated difficulty of improving the cost estimate will have to be balanced to determine which elements need more work.

In addition, the importance of individual cost-element estimates can be assessed to help determine which cost elements should be examined and which ignored when analyzing decision alternatives, or when conducting a sensitivity analysis for underlying variables. After a supplementary look at the same decision (or a close variant), the assessment will give some guidance about what to do first, how much must be done to achieve a given level of accuracy, and what can be safely ignored unless the decision changes significantly.

SUMMARIZING COST RESULTS

The final step in the resource and cost-accounting process involves the summary and presentation of cost results. Because recurring and nonrecurring costs are different, that task will often involve more than the simple addition of the cost elements. Ultimately, the manner in which nonrecurring and recurring costs are combined will depend on the purpose of the analysis. For example, in some cases the computation of "net present value" (using an appropriate discount factor) will suffice. However, decisionmakers proposing force structure changes to achieve budget savings may be more interested in the "break-even point," the number of years before a decision will result in a net savings.

In any case, summary cost information that is advanced should be presented in the context of the resource, activity, and mission changes that it entails. As demonstrated in Sec. II of this report, less complete descriptions of force structure changes can render cost results

meaningless. Decision costs of force structure changes are significant only when they are associated with the underlying changes in inputs (e.g., manpower and equipment) and outputs (e.g., unit missions). Thus, the estimated cost consequences of force structure change should be clearly and specifically related to their respective balance sheets.

V. CONCLUSIONS

As the role of the reserves in the total force continues to evolve, the Services will face a growing number of questions concerning the nature of that role. What types of units should be placed in the reserves? What wartime missions and peacetime functions should they serve? How should those units be manned and equipped?

Our approach to the costing of active/reserve force-mix questions calls for a renewed emphasis on the *problem definition* phase of a decision analysis. In other words, before meaningful cost estimates can be developed, one must first answer such questions as, What is to be costed? What is to be held constant? Which resources are newly allocated and which are simply reallocated? What are the full consequences of a decision? Ignoring these questions, we have shown, can lead to an extremely large variation in cost estimates for what appears to be the same decision.

Without a structured approach to problem definition, several potential problems arise that are associated with the costing of active/reserve force-mix decisions. These problems stem from the observation that although force structure questions are usually expressed in rather broad unit-level terms, changes occur on the much more detailed level of resources, such as manpower and equipment. An overly simplified unit-level approach to the costing of active/reserve force structure changes can leave underlying resource changes ambiguous, critical assumptions unjustified or unexplored, and major problem components unaddressed. As a result, cost conclusions would prove of little use in informing force structure decisions.

Section III of this report developed a detailed and comprehensive accounting structure for describing net changes in DoD resources, missions, and functions that accompany changes in the active/reserve balance. Having followed that structure, the cost analyst is then ready to complete the analysis by translating the net resource and activity changes into costs or savings to the DoD.

We believe that following the procedure outlined in Sec. III will improve decisionmaking by more closely tying costs to the policies being evaluated. On the one hand, completely documenting and properly qualifying cost results will help ensure that appropriate conclusions about the costs of decisions are drawn. On the other hand, the ability to link costs to real decisions will facilitate identification and investigation of cost tradeoffs, and make it possible to ask informed

"what if" questions. As a result, costs can play an increasing role in the decisionmaking process.

In addition to the main benefits, we believe this procedure will have beneficial side effects. First, the process may uncover valuable new alternatives. For the decisionmaker, the careful and explicit representation of a complete decision may identify areas of uncertainty that warrant specific examination. For the cost analyst, unresolved doubt on the specifics of a decision will naturally lead to the creation of cases that explore the consequences of alternative resolutions of that ambiguity. Further, these extensions to the analysis need not involve prohibitive time and cost expenditures. The process is sufficiently structured to benefit from the efficiencies of computerization.

Second, the procedure will facilitate the integration of cost with capability issues. By making all resource changes transparent, and by specifically addressing changes in war and peacetime missions, capability effects will more easily be addressed, the tendency to generalize from costs alone will be checked, and the integration of quantitative analysis with experience, judgment, and intuition will be facilitated.

Several extensions to the present report (and its associated *Cost Element Handbook*, R-3748/1-FMP/PAE/JCS) are planned. First, we will further demonstrate and extend the methodology by its application in three case studies, one each in the Air Force, Army, and Navy. Unlike the example in the present report, the case studies in R-3748/2-FMP/PAE will span a wide range of force structure changes and cost issues that can arise in the context of active/reserve force structure changes. The cases will be based on actual active/reserve issues that arose in the context of developing the federal defense budget. We expect that the process of applying the methodology to specific cases will lead to additional suggestions for further research.

Second, we plan to recast the methods used in this report in the form of a users' guide for cost analysts interested in establishing the full scope of active/reserve force structure problems. Written in the form of a question list designed to uncover the major cost-drivers of force structure decisions, its step-by-step method will guide analysts in the execution of cost studies.

Finally, RAND is investigating the benefits of computerizing the active/reserve cost methodology. A prototype system for automating the methodology has been designed and documentation is under way. Computerization will improve the speed and accuracy of cost analyses, and provide the means for extending analyses to a greater number of alternatives and to a more in-depth examination of costing issues. It will also provide a convenient method of documenting results.

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