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Active-Reserve Force Cost Model

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Executive Summary

This paper describes a set of methods and related tools developed for incorporating cost into force-structure decisions involving a mix of Active Component (AC) and Reserve Component (RC) units of particular types. The development effort was initiated in response to Objective 1 of the "Comprehensive Review of the Future Role of the Reserve Component,"[1] which sought the development of a consistent, widely accepted cost methodology for determining force mix. Determining the best mix of Active and Reserve units is an important element of defense planning and force sizing. Active units are often better able to deploy on short notice than Reserve units, and can be deployed more frequently. Reserve units, on the other hand, are less expensive on a unit-for-unit basis, allowing a larger force structure to be maintained for a given level of expenditure. We have developed this methodology and set of associated computer-based tools to facilitate comparison of alternative AC-RC force mixes for the Office of the Secretary of Defense (OSD), the Joint Staff, and the Services.

The method permits quick comparison of several alternative force mixes with respect to cost, strategic capacity, and operational capacity. Our approach is to help decision makers find the least-cost AC-RC mix that can:

- Include acceptable surge capacity, as measured by total force size including strategic, rotational, and deployed units or systems
- Attain acceptable steady state operational or presence levels, as measured by the number of units a force of a specified size and AC-RC mix can maintain to support potential deployments on a continuing basis

We do not address possible differences in the capability or effectiveness of Active and Reserve units of a given type, assuming that once trained for deployment, units are equally effective. We also do not address the ability of a force structure to respond expeditiously to a surge in demand. We address the steady state costs of alternative force structures but not the costs of transitioning from one force structure to another.

A key element of our approach is to focus the analysis at the *community* level. By community, we mean the set of units of a given type: mission, platform, or capability. We do this because AC-RC force-mix decisions are made at the community level: the mixes

[1] Office of the Vice Chairman of the Joint Chiefs of Staff and Office of the Assistant Secretary of Defense for Reserve Affairs, "Comprehensive Review of the Future Role of the Reserve Component, Volume I, Executive Summary & Main Report," April 5, 2011, 3.

of armored brigade combat teams or C-130 aircraft, for example. The tool allows the user to consider the cost analysis in the context of the concept of operations (CONOPS), both strategic and operational, for the entire community over a multi-year period. Focusing on the cost of individual units or the cost of deploying a single unit from either the Active or Reserve Components does not address outputs from the utilization of the entire community. However, an integrated analysis of alternative mixes for a given community gets to the core of being able to determine the most cost effective mix with acceptable strategic and operational risk. The methodology is designed ultimately to provide not just cost, but cost linked to measures of operational and strategic capability.

An important aspect of the tool is the consideration of the activity and related costs of the community over multiple years. Multi-year analysis provides a truer picture of community costs, as it can incorporate deployments, rotations, future modernizations, and other factors that vary within a unit from year to year. The tool considers cost over a multi-year period and distills it down to an average annual cost for the entire community.

Separately tailored, but similarly structured, tools demonstrating force-mix analysis are provided for each of the four Services. Each tool includes cost factors reflecting personnel, training and operations (both non-deployed and deployed), equipment replacement, munitions, infrastructure, and deployment. One goal of our modeling effort is to identify as many cost factors as possible, both direct and indirect. The tool is adaptable and supports a wide range of policy analyses. Cost and operational capability implications can be evaluated for changes in assumptions, including equipping strategy, personnel policy, rotation rate, CONOPS, and training tempo.

Despite a majority of shared concepts, the coverage provided by the tools for each Service differs significantly. Both the Army and Marine Corps tools address units of all kinds, both combat and support. The Air Force tool addresses flying units only, including those using unmanned aerial systems. The Navy tool addresses only units belonging to the Navy Expeditionary Combat Command (NECC), responsible for expeditionary forces other than ships and aviation such as construction battalions and demolition teams. This is because we were able to draw on NECC modeling not available for most of the Navy.

Personnel-related cost factors come from Service and OSD sources. Equipment operating cost factors covering energy, consumables and repair parts, depot-level reparable parts, and depot maintenance come from Service databases. For the most part factors related to infrastructure costs are based on information in the Future Years Defense Program (FYDP).

The cost elements captured by the tool are summarized in the table on page v.

Summary of Cost Elements

Personnel	Basic Pay and Allowances/Drill Pay Retired Pay Accrual Housing Allowances Cost of Living Allowance (COLA) Special Incentive/Hazardous Duty Pay Permanent Change of Station (PCS) Travel: Military & Dependents
Equipment Operations and Maintenance	Energy Transportation Depot Maintenance Depot Level Reparables Consumables and Repair Parts
Procurement	Procurement of Equipment Replacement of Training Munitions and Expendable Stores
Indirect	Personnel Benefits Personnel Administration Education and Individual Training Installation Support Medical
Deployment (may include any incremental cost from the first four categories)	Incremental Pay and Allowances for Activation and Deployment Personnel Support Incremental Operations and Maintenance Transportation

Users can specify a wide range of user inputs in order to assess force-mix alternatives tailored to their interests and needs. These include:

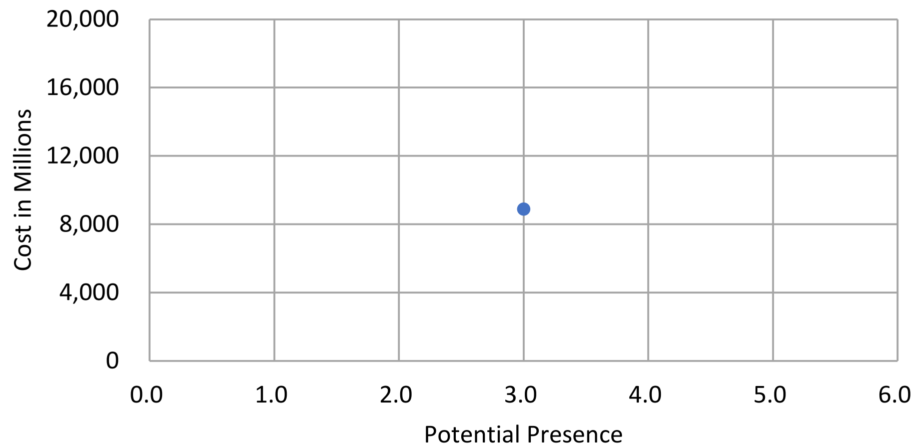
- Community – the type of platform, system, capability, or unit to be addressed
- Force levels by Component – the set of force-mix alternatives to be studied
- Use and rotation patterns – This is critical for determining how much rotational operational capability a community provides. Rotational unit types train and resource according to a periodic cycle supporting a unit's availability for deployment. Non-rotational unit types are primarily strategic and do not support rotational availability. Multiple CONOPSs for a community of AC and RC force elements can be tested by placing units in any of four categories:
  - Rotational unit types: units that train for periodic deployment
    - Available: units that train and resource for periodic deployment availability but do not deploy when available
    - Rotating: units that train and resource for periodic deployment availability and do deploy when available

  - Non-rotational unit types: units that do not train for periodic deployment
    - Strategic: garrison units available only for surge activity and resourced at a relatively lower level than a typical unit.
    - Deployed: operational units permanently stationed in a forward location and resourced at a relatively higher level than a typical unit.
- Resource and activity levels – equipment on hand, AC and RC personnel manning, operating tempo relative to Service norms, etc. Resource and activity levels are variable with time for rotational unit types
- Equipment and ammunition replacement costs, if desired, under a range of assumptions determined by the user about what drives them
- Indirect costs – personnel administration, personnel benefits, installation support, and individual education and training. Users can specify the extent to which these kinds of costs are treated as varying with force structure
- Deployment costs that estimate transportation associated with initiating and sustaining deployments as well as incremental personnel and operating and support costs associated with contingency operations

The key numerical outputs of our modeling are:

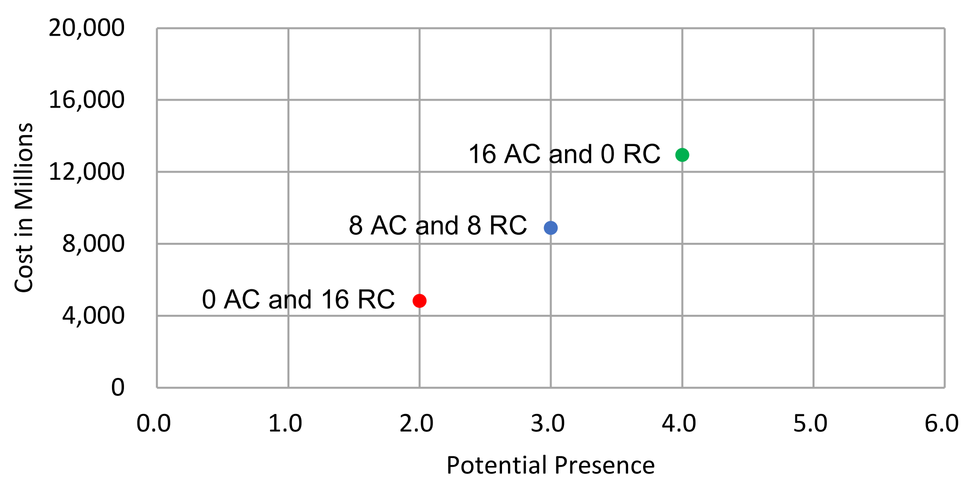
- The average annual cost of the entire community for a selected force mix under a set of user-specified operational and resourcing assumptions and inputs. The average annual cost is derived from integrated examination of the costs of activity and rotations over multiple years.
- The surge capacity provided by the community. This is measured either by the total number of units in the community or, in the case of the Air Force, the maximum number of flying hours or sorties the community could produce. Surge capacity is effectively treated as an input in the methodology implemented in the supporting computer-based tools.
- The steady state level of operational capability, as measured by the number of units or the hour/sortie output the community can produce for deployment on a continuing basis according to user-specified rotational policy

As part of the output, graphical displays are produced based on the user-specified alternatives. The first figure on page vii is based on a notional community with 16 units, a force mix of eight AC and eight RC units, and a set of assumptions regarding resourcing and rotation patterns. This display shows the annual average cost of the community on the vertical axis. The horizontal axis shows the potential presence or deployment capability (operational capacity) of that community—in this case, approximately three units. Strategic capacity is defined as the total number of AC and RC units—in this case, 16. The force mix is displayed as a single (blue) point.



Graphical Depiction of a Single Force-Mix Alternative (8 AC and 8 RC Units)

In the figure below, we expand the original depiction to include two new force-mix alternatives at the extreme boundaries of the force-mix spectrum, in addition to the alternative shown above. One (red) point represents a community of zero AC and 16 RC. The other (green) point shows a community of 16 AC and zero RC. Under the assumption that cost factors are independent of the AC-RC mix, a straight line could be drawn across the three points to show all possible 16-unit force-mix alternatives. If the cost factors were not independent of the AC-RC mix, the line would be non-linear. Additional displays showing the sensitivity of this result with respect to the AC-RC mix, the extent to which available forces are deployed, and force size are automatically generated.



Graphical Depiction of Three Force-Mix Alternatives (16 Units)

The treatment of Air Force operational capability is substantially different from that of the other Services, primarily due to operational capability produced while not deployed. Many kinds of non-deployed Air Force units routinely generate operational capability. For example, cargo aircraft in the continental United States (CONUS) provide transportation services. Thus, for the Air Force we model the generation of both deployed and non-deployed operational capability. Non-deployed operational capability is determined by means of user-input information on the fraction of non-deployed flying that can be devoted to operational activity. Non-deployed operational output is not unique to the Air Force; however, it is not addressed in detail for Services other than the Air Force in this document. The computer-based tools developed to support this methodology do support limited measures of non-deployed operational output for the other Services.

The illustrated methodology for comparing AC-RC force-mix alternatives gives insights into the costs and capabilities associated with selected alternatives, but it is incomplete. Its results should be considered with the following caveats in mind:

- Transition (that is, unit conversion) costs are not considered. Changes in the mix of Active and Reserve units could take time and entail costs.
- The rate at which surge forces can be generated is not addressed.
- Some cost factors that we take to be constants may not be, for substantial shifts in AC-RC mixes for large communities. Training costs are an example.
- Differences in effectiveness between AC and RC units are not addressed.

Our current modeling structure provides a better-informed starting point for analyses of AC-RC force structure by assisting in the identification of the AC-RC mix that can least expensively meet both surge and operational requirements. It focuses on community-level decision making by providing multi-year analysis of the cost behavior of the entire AC-RC community. The tool provides a platform for quick sensitivity analysis of a host of variables that affect community cost and allows the decision maker to understand the available trade space including policy, CONOPS, cost, operational capacity, and strategic capacity variables. The tool is also useful in analyzing the community costs of two separate platforms that provide similar capability. This includes similar unit types, systems such as aircraft, and manpower. Last, it provides an approach for consistent conduct of AC-RC cost and force-mix analyses.

Contents

1. Introduction

A. Objective and Outline

The purpose of this paper is to describe a methodology and set of supporting computer-based tools for incorporating cost into force-structure decisions involving the mix of Active Component (AC) and Reserve Component (RC) units of particular types. This development effort was initiated in response to Objective 1 of the "Comprehensive Review of the Future Role of the Reserve Component,"[1] which sought the development of a consistent, widely accepted cost methodology for determining force mix. Determining the best mix of Active and Reserve units is an important element of defense planning and force sizing. Active units are often better able to deploy on short notice than Reserve units, and can be deployed more frequently. Reserve units, alternatively, are under some assumptions, less expensive on a unit-for-unit basis, allowing a larger force structure to be maintained for a given level of expenditure.

These tools provide a quick capability to assess a wide range of AC-RC force-mix alternatives for impacts on cost and operational capacity (generation of routinely available units), given a necessary surge capacity (deployment of all units). The tools give a decision maker experience with the trade space among policy, operations, equipping, and cost variables for a given community. The paper is meant not only to familiarize potential users with the important analytical concepts that support the tools, but more importantly to inform approaches to force-structure costing in general. The paper provides an analyst with a template for designing force-structure and force-mix alternatives but does not evaluate any particular alternative.

The remainder of this chapter describes general features of the cost tools that are common to all the Services including graphical displays of model output. Subsequent chapters address the common and peculiar components of the Service-specific tools. The paper concludes with a short discussion of key points. The goal is to support continuing force-structure analyses and the use of consistent tools, informing analysts of the options available for structured and repeatable examination.

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1 Office of the Vice Chairman of the Joint Chiefs of Staff and Office of the Assistant Secretary of Defense for Reserve Affairs, "Comprehensive Review of the Future Role of the Reserve Component, Volume I, Executive Summary & Main Report," April 5, 2011, 3.

B. General Approach

Two key elements of our approach are to focus force-mix analysis at the community level and apply the analysis over multiple years. By *community*, we mean the set of modeled units, such as all armored brigade combat teams (ABCTs) in the Army. Units, within the context of this study, characterize not only traditional ground units, but also aviation systems, or any representative military organization. The point of AC-RC force-mix analysis is to understand the specific and unique costs appropriate to force-structure costing and the effectiveness of multiple community force-mix alternatives. Examining a community over a range of durations allows one to factor in deployments, modernization, and other anomalies that may be inappropriate to include in a one-year analysis. This provides a truer picture of the cost of a given force structure and Component mix.

Our modeling structure is meant to provide a better-informed starting point for cost-capability analyses of AC-RC force structure alternatives. While it cannot provide conclusive evaluations, it does provide a consistent methodology for analyzing alternative AC-RC mixes for a wide range of unit types. The tool puts the focus on critical factors such as community-level cost, strategic capacity (measured by community size) and operational capacity (measured by the number of units generated for routine deployments in a non-surge environment). It captures most potential costs from a force-structure costing perspective as well as the characteristics of rotational use of both Active and Reserve Component units, including the level of resources available to units at various points in a rotational cycle. Because the tool captures the AC and RC costs over their respective rotational cycles, the force-mix alternative analysis covers multiple years. Additional details are provided in the remainder of this chapter.

The tool does not address:

- **Transition, or unit conversion, costs**. Changes in the mix of Active and Reserve units might take time to complete, and might entail costs that are ignored. Categories of such costs might include separation, disposal, and construction.
- **The rate of force generation in surge**. The total number of units in the force structure, or hours/sorties generated by those units in the case of the Air Force, is used as the measure of surge capability. The ability to have the capability available within a specified period of time after an alert is not considered. (Although force size is not adjusted for effectiveness, units assumed to be less ready to deploy may generate reduced presence or fewer hours/sorties.)
- **Variation in cost factors as a function of AC-RC mix**. For example, it may be presumed that RC units in RC-intensive communities cannot benefit as much as RC units in AC-intensive communities from training costs borne by Active units. This implies training costs for reservists should increase as the

contribution of Active units to a community decreases. Such a relationship is not built into the cost factors we use. We investigated variation in these factors in detail and did not identify consistent relationships. The tools we developed do allow the user to vary these costs in the form of a direct user input using a set of accounting assumptions.

- **Potential differences in the effectiveness of units from different Components**. It is possible that units deployed from the Reserve Component may not perform at the same level as those deployed from the Active Component due to differences in manning, resourcing, and training.

1. Inputs

a. Pre-specified Cost Factors

The cost factors used in our calculations are largely derived from existing Service models and Department of Defense (DoD) data sources. Table 1 summarizes the cost elements captured by the tool across the Services. They fall into five major categories: personnel, equipment operations and maintenance (O&M), procurement, indirect, and deployment. We seek to identify the marginal costs associated with units: specifically the marginal cost of force structure per year over time. The tool is designed to be flexible with respect to the term of the analysis. A short-term marginal cost analysis might be limited to personnel, equipment O&M, and a portion of indirect cost elements. Alternatively, a long-term cost analysis might include additional cost factors related to procurement and a greater share of indirect cost factors, up to and including 100 percent variability of indirect costs with changes in force structure.

The elements of personnel costs constituting Regular Military Compensation—basic pay and allowances, retired pay accrual, housing allowances, cost of living allowances, special incentive and hazardous duty pay, and permanent change of station expenses—come from Office of the Secretary of Defense (OSD) sources, consistent with OSD guidance.[2] These are supplemented with Service sources where necessary. Some additional personnel-driven charges are treated as indirect costs; their derivation is described later in this section. Defense Health Program costs come from OSD sources.[3] Personnel accession and initial training costs are treated as indirect costs, and the cost factors are derived from Future Years Defense Program (FYDP) data.

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[2] John P. Roth, "FY 2013 Department of Defense Military Personnel Composite Standard Pay and Reimbursement Rates" (Washington, DC: OUSD (Comptroller), April 2012).

[3] Ibid.

Equipment operating cost factors covering energy, consumables and repair parts, depot level reparable parts, and depot maintenance come from Service databases, in most cases. Depot maintenance costs may or may not be included for non-deploying units; for example, such costs are not included by default for non-deployed units in the Army, but are included for non-deployed units in the Marine Corps. Our treatment mirrors that of the Services. Operating costs may additionally include a user input for the cost of modernization activity. In most cases this will be a portion of the value of the unit measured on an annual basis.

Table 1. Summary of Cost Elements

Personnel	Basic Pay and Allowances/Drill Pay Retired Pay Accrual Housing Allowances Cost of Living Allowance (COLA) Special Incentive/Hazardous Duty Pay Permanent Change of Station (PCS) Travel: Military & Dependents
Equipment O&M	Energy Transportation Depot Maintenance Depot Level Reparable Consumables and Repair Parts
Procurement	Procurement of Equipment Replacement of Training Munitions and Expendable Stores
Indirect	Personnel Benefits Personnel Administration Education and Individual Training Installation Support Medical
Deployment (may include costs from the first four categories)	Incremental Pay and Allowances for Activation and Deployment Personnel Support Incremental Operations and Maintenance Transportation

Procurement costs are derived from Service data on equipment replacement costs and ammunition consumption, where available. While most equipment is replaced or refurbished infrequently, some replacement or refurbishment does occur every year. This cost factor is meant to capture the average level of such expenditures over time and can be excluded if desired, such as in analyses of the short-run marginal cost of operating a community. Equipment life differs by the type of equipment; however, users may modify assumptions regarding equipment life only on an average basis for each Component. In a long-term analysis, if the approximate cost of equipment modernization is known, or can be estimated, the tool can capture those costs. A secondary benefit is the ability to use the model to estimate the cost of alternative equipping strategies.

For the most part, indirect costs are derived from information in the FYDP. The Institute for Defense Analyses (IDA) has categorized spending into force and infrastructure categories.[4] Among these categories are personnel benefits, personnel administration, education and individual training, and installation support. Spending in each category is an aggregation of spending at the program element (PE) level. Costs reported as expended by a specific Component within these categories are assigned directly to that Component in the tool. Costs reported across the Components are allocated according to the number of full-time equivalent (FTE) personnel in each Component.[5] This attribution is imperfect in part because indirect costs may vary with the number and mix of units. Because of this, we give users considerable discretion in deciding what indirect cost factors to use. The nature of this discretion is described later in this chapter.

As noted above, the cost factor for one element of indirect costs, the provision of medical care to Service members and their families, comes from OSD sources.

Deployment costs are included in our calculations because, while many of the marginal costs associated with a single deployment are very similar for an Active or Reserve unit of a given type, not all of them are. For example, reservists receive more pay when they are activated. Also, if Active and Reserve units have deployments of different durations over different deployment cycles, the total cost of deployments may differ with the mix of AC-RC units. In our tools, deployment cost factors are primarily derived from factors supporting IDA's Contingency Operations Support Tool (COST). The factors supporting this tool are sourced from throughout DoD and from internal IDA studies and analyses. OSD Comptroller and the Services have used COST to estimate funding required for deployments for the last fifteen years.

b. User-specified Inputs that Enable Sensitivity Analysis

An important feature of the tool is that by altering inputs iteratively, users can quickly perform sensitivity analysis along many dimensions, seeing the implications for both the cost and operational capacity of alternative choices. Being able to adjust a host of variables in the tool allows the decision maker to identify potential trade space amongst many factors, such as concepts of operations (CONOPS), rotational policy,

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4 Ronald E. Porten, Daniel L. Cuda, and Arthur C. Yengling, "DoD Force & Infrastructure Categories: A FYDP-Based Conceptual Model of Department of Defense Programs and Resources," IDA Paper P-3660 (Alexandria, VA: Institute for Defense Analyses, September 2002).

5 In general, part-time reservists are considered to be 20 percent of an FTE.

equipping strategies, and marginal cost assumptions. The user-specified inputs are discussed in the subsections below.

1) Community

Selection of the community of units or systems to be analyzed—the type of unit or system—is the first step in examining a force-mix alternative. The tools created for this project have been provided with simple pull-down menus for the purpose of selection. The first in-depth force-mix alternative run through the tool may be an analysis of the current status quo force mix of the selected community. Examples of available community choices include ABCTs in the Army, Infantry Battalions in the Marine Corps, and F-16s in the Air Force.

2) Force Levels by Component

A central part of defining an analytic alternative is specifying the mix of AC and RC units or systems to be addressed. The number of units or systems in each Component is entered directly by the user and can be varied to consider a wide range of alternatives.

Providing a measure of cost and capability for a specified force structure is a standard function of most modeling methodologies. An important element of this specific implementation is the capability to quickly consider alternative force structures, including larger and smaller communities, within the context of an initial force structure.

Consider an ABCT force structure that includes ten Active and ten National Guard units. The modeler may want to consider the impact on cost of a reduced Active complement of eight units and an increased National Guard complement of fifteen units. The tool allows the user to consider this alongside the target force structure by presenting a sensitivity analysis that reduces the Active force by 20 percent and increases the Reserve force by 50 percent. These percentages can be entered directly in each Service-specific tool.

3) Use and Rotation Patterns

The frequency with which units are available and deploy is an important factor driving the relative cost of Active and Reserve forces. The user has great flexibility in choosing deployment assumptions. In fact, the tool allows the modeler to test the impact of variation in the CONOPS, utilization, and AC-RC integration. Both AC and RC units can be designated in any one of four representative categories:

- Rotational unit types: units that train for periodic deployment
  - **Available** – units that train and resource for periodic deployment availability but do not deploy when available

- **Rotating** – units that train and resource for periodic deployment availability and do deploy when available

- Non-rotational unit types: units that do not train for periodic deployment
  - **Strategic** – garrison units available only for surge activity and resourced at a relatively lower level than a typical unit
  - **Deployed** – operational units permanently stationed in a forward location and resourced at a relatively higher level than a typical unit

The mix of rotational unit types—how many are treated as available for deployment and how many as rotating—should reflect the user's estimate of the demand for deployment. It is meant to reflect the expected state of the world, not force management policy. Both kinds of rotational units can, but need not, move through readiness phases. For example, availability for deployment may be followed by a reset period and then by several periods of increasing training and readiness before the next deployment availability period. Strategic and deployed forces are modeled with single resourcing phases. Strategic units may be modeled as units manned, resourced, and trained at minimal levels designed to support only a surge requirement. In that respect, the cost of a strategic unit may be regarded as the minimum cost of *any* unit in the force structure. Thus, the marginal cost of the additional output produced by rotational and deployed units may be viewed as the difference in cost between those units and strategic units of the same unit type.

The phase structure for deployments will usually differ for AC and RC units, with Reserves available for deployment less frequently. The amount of operational capability the community can generate will be determined by the fraction of time rotational units can spend deployed, and, optionally, the number of permanently "deployed" units in the community. For rotating units, the user must specify the portion of time in mobilized status that is actually spent deployed. Typically, RC units spend some of their mobilization period training for deployment and adjusting after deployment. For rotating units in all Components the user may use the phase structure—by decreasing the portion of mobilization time deployed—to allow for transit time and overlap between deploying units and the units they are replacing.

4) Resource and Activity Levels

Phase duration and resourcing is set by the user and depends on policy and concepts of employment. Resource levels relative to fully resourced units must be specified for equipment on hand, Active personnel, Reserve personnel, and infrastructure. The general activity level, or operating tempo (OPTEMPO), must also be specified for every phase relative to activity in a fully resourced non-deployed "dwell" environment. As AC and RC units progress through the rotational cycle, additional training can be added in each phase leading to full readiness for deployment. The choice of resource and activity levels affects the cost of units in every phase.

In order to limit the requirement for additional training during mobilization and to ensure the readiness of deploying RC units, it may be desirable to provide additional training days for the RC in the phase or phases prior to mobilization. Our tools provide for the provision of such training by altering the activity level. This affects the cost of using the RC rotationally by increasing the cost of equipment O&M and the cost of RC personnel as they progress through the cycle.

5) Equipment Replacement Cost

The tool allows users to choose the life of equipment and to incorporate replacement cost into their analyses of alternatives. If included—short-run analyses may choose to exclude these costs—equipment replacement costs are attributed to a unit according to either the complete table of organization and equipment (TOE) or only the portion of the equipment held by the unit directly. The fraction of authorized equipment on hand can vary by phase. This flexibility allows the user to experiment with various equipping strategies.

The fact that equipment on hand may be used less intensively by Reserve units than by Active units is not taken into account in calculating equipment replacement cost. However, O&M costs will reflect the lower utilization and lower OPTEMPO of Reserve units. Also, if less used equipment is rotated throughout the community, service life may be extended and replacement delayed. Because it is impossible to know how replacement equipment may differ from current equipment, we assume that the cost of replacement equipment is the same as that of the equipment being replaced.

6) Indirect Cost Elements

Cost factors for personnel administration, personnel benefits, installation support, and individual education and training are based on historical FYDP data. Per capita spending in each category is calculated for Active, full-time Reserve, and part-time RC personnel. Where the data are not available and cannot be assigned to a Component, a per-FTE assignment is used. It is assumed that a reservist is 20 percent of an FTE on an annual basis. For each category of cost and Component, the user may specify what percentage of this spending varies with the number of personnel. At least in the short-run, it is quite possible that a portion of these indirect costs do not change with force size, and users can set that portion at any level between zero and 300 percent. Thus, if specific estimates for the portion of indirect costs attributable to a unit can be made for various force-mix alternatives, the tool can accommodate the information. The default treatment sets the variable portion of indirect costs at 50 percent.

7) Deployment

Users may specify the length of transportation associated with initiating and sustaining deployments. Air miles, ground miles, and sea miles may all be entered. It is not expected that users will have detailed knowledge of deployment and resupply distances, but notional inputs are required to capture differential deployment costs associated with possible differences in the length of Active and Reserve deployments.

2. Outputs

The modeling provides three key numerical measures:

- The **average annual cost** of the entire community for a force mix across a time-phased cycle of the user's design. The cost includes the cost of strategic, available, rotating, and deployed units in all Components of the community. The methodology supporting this output produces an average annual cost across the complete cycle, which can stretch across multiple years. The cycle may include phasing that varies resource levels and activity as a unit or system remains in a low-readiness status or is trained to meet a specific requirement. Costs are displayed separately for each Component and reported by cost category: personnel, operations, indirect, procurement, deployment, and other.
- The **surge or strategic capacity** provided by the size of the community. This is measured either by the total number of units in the community—Active plus Reserve Components—or in the case of the Air Force, the maximum number of hours or sorties that a community could produce. This is a throughput, since force size and force activity is user-specified. The model assumes strategic capacity is the first and most important consideration in force design.
- The steady state level of **operational capability**, as measured by the number of units, or hours/sorties, the community can produce for deployment availability on a continuing basis according to rotational policy.

3. Introduction to Modeling Concepts

This section provides a detailed introduction to the primary modeling concepts, displayed graphically, used to report the three key numerical outputs for a community. The displays present the total cost of a community along the y-axis and its operational capability along the x-axis. Surge capacity is reported directly for a given community as the total number of units in that particular alternative. Each of the following figures builds upon the previous to present additional information regarding the use of outputs and the impact of important settings and assumptions.

Beginning with Figure 1, we introduce a community of 16 units of a notional type and Service. This community includes eight Active units and eight Reserve units, with each Component including four "available" and four "rotating" units. There are no non-rotational units. Cost and rotational presence are displayed appropriately as a single (blue) point. This 16-unit community produces 3.0 units of operational capability (or potential presence) at a total cost of approximately $9.1 billion per year. The (blue) point in Figure 1 is the initial point from which the analysis develops further.

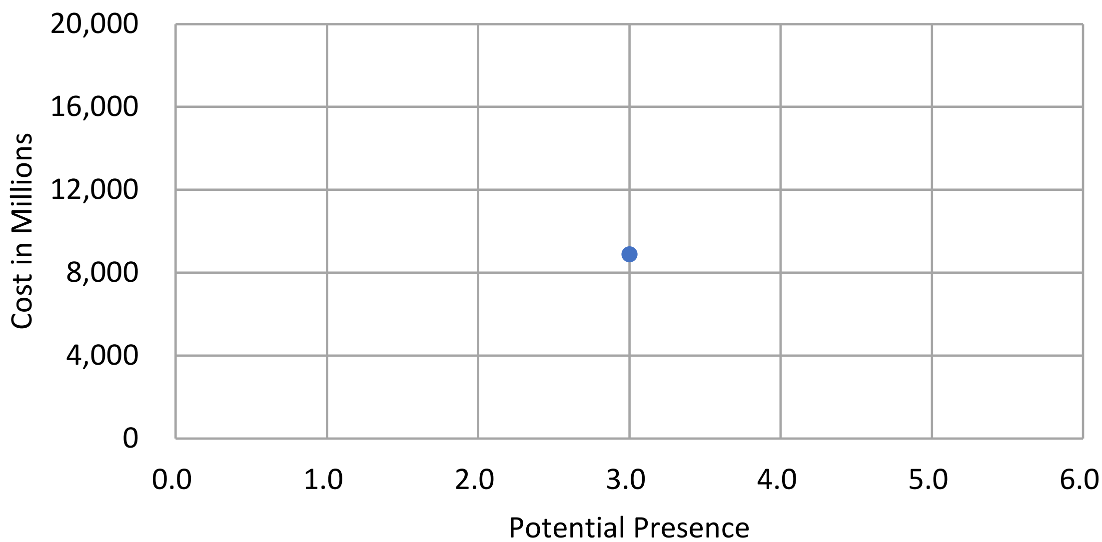

Figure 1. Point Estimate of Cost and Potential Presence (8 AC and 8 RC)

The point estimate is a direct reflection of user inputs; it does not provide information on the sensitivity of the result to changes in inputs. To consider sensitivity to rotation policy, for example, the rotation rates can be modified for AC, RC or both. Figure 2 tests the sensitivity of AC-RC mix by adding an additional dimension to the output: varying the percentage of units in the AC and RC. The (red) point is a 100 percent RC, 16-unit community. It is less expensive than the original force structure with less potential presence. The (green) point is a 100 percent AC, 16-unit community and is more expensive than the original force structure with greater potential presence. Joining these points shows the complete range of possible mixes for a 16-unit community where 50 percent of rotational units deploy.

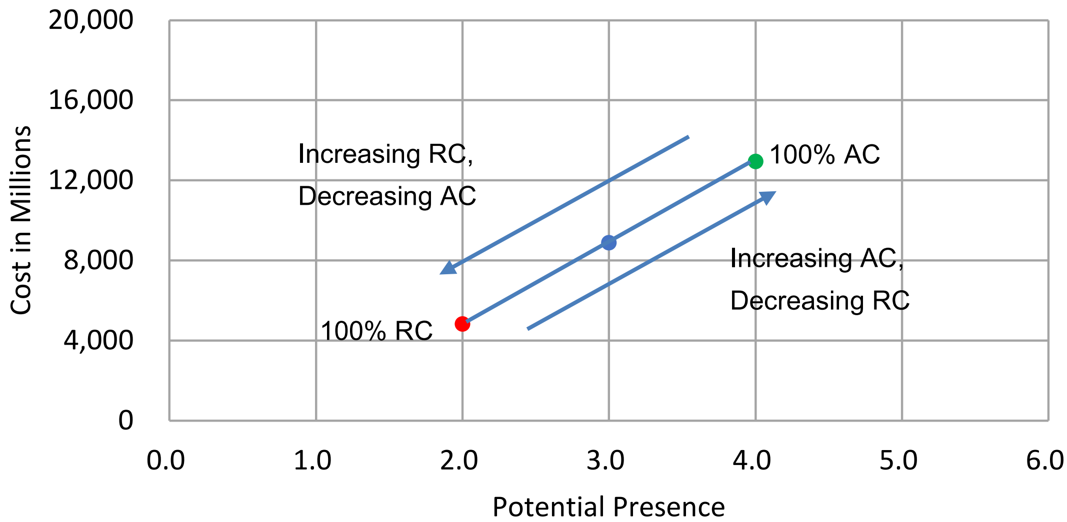

Figure 2. Effect of Varying the AC-RC Mix on Cost and Presence (16 Units)

The slope of the line in Figure 2 illuminates the cost savings RC units generate relative to AC units and the trade in terms of reductions in the level of potential presence. The extent to which this function is linear in practice is not known. Research on indirect costs associated with this report did not support a significant non-linear relationship, at least with respect to changes in units and personnel.

Figure 3 adds a further dimension by varying the percentage of rotational units that deploy when they are available for deployment. This creates a two-dimensional region that illustrates the implications of this additional variation. Figure 1 and Figure 2 assume rotational units deploy 50 percent of the time. The (red) frontier at the top of the region in Figure 3 denotes a set of force mixes in which units deploy 100 percent of the time. The (green) frontier at the bottom of the region denotes a set of force mixes in which none of the units deploy. This region thus includes the complete set of possible rotational units from zero percent deploying to 100 percent deploying. Reflecting the fact that RC units are less costly for this community, and rotating units cost more than available units, the region slopes upward to the right. The upper right of the region, Point A, thus represents a force that is 100 percent AC and always deploys when available. The lower left point of the region, Point B, represents a force that is 100 percent RC and never deploys when available. This region thus displays sensitivity to both force-mix and deployments.

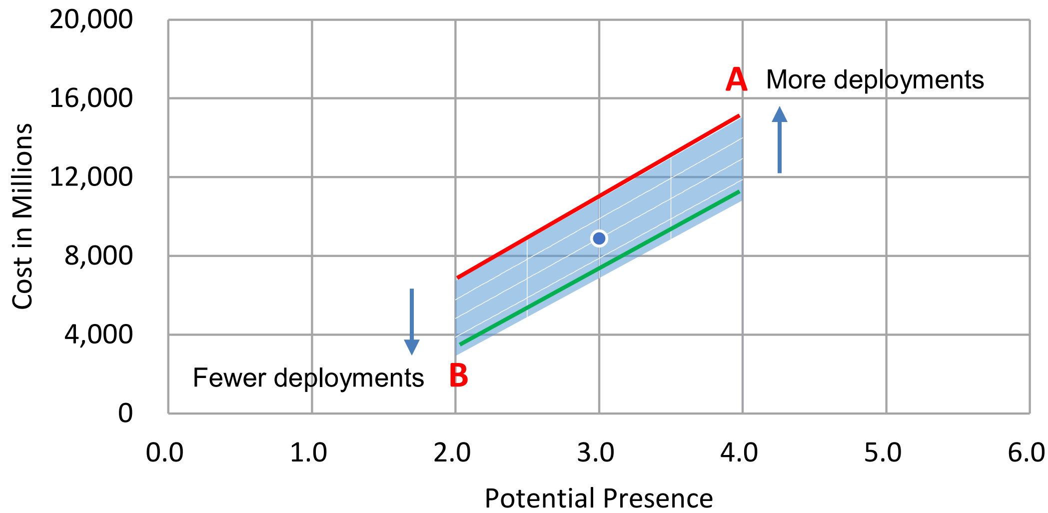

Figure 3. Varying the AC-RC Mix and the Percentage of Units that Deploy (16 Units)

Note that in this case, the savings from not deploying are similar for Active and Reserve forces. If the analyst chooses to keep non-deployed but available Reserve forces in a non-mobilized status (as may make sense for the Air Force) the savings from not deploying will be greater for the RC, changing the shape of the region.

The previous figures include only rotational units. Figure 4 adjusts this 16-unit force mix by moving four units into the "strategic" category (lower readiness without rotational availability) with two units assigned each to the AC and RC. Strategic units generate costs and surge capacity, but no operational capability. This assignment reduces maximum cost, reduces operational capability (or potential presence), and shrinks the region: the resulting region is smaller and moves generally down and left.

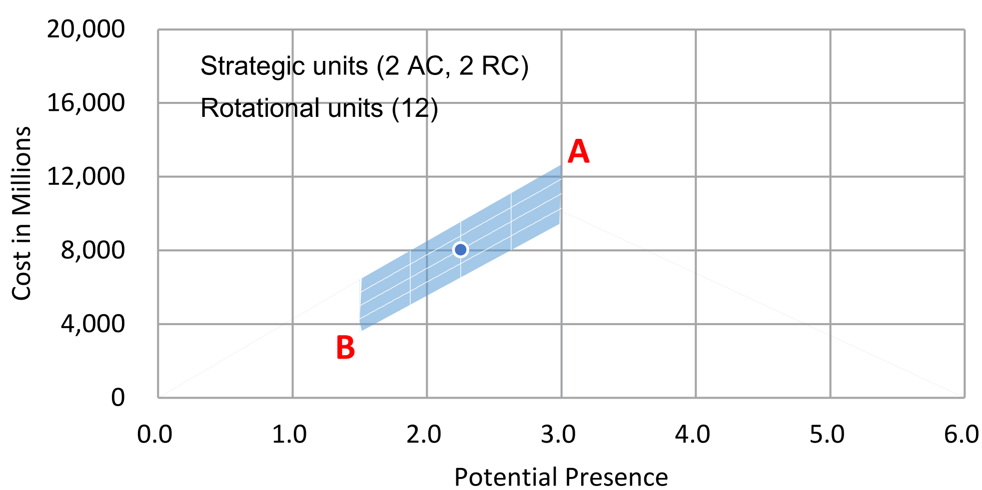

Figure 4. Replacing Rotational Units with Fixed Strategic Units (16 Units)

Note that because the minimum number of AC units is set to two, rather than zero, the lower bound of the region in Figure 4 is higher than in Figure 3. This can be observed by comparing Point B in Figure 3 with Point B in Figure 4. Similarly, the reduced availability and minimum number of RC units set to two decreases maximum potential cost. This is obvious when comparing Point A in Figure 3 and Figure 4. Fewer units are resourced and tasked to generate rotational availability. In general, increasing the number of strategic units will reduce cost, reduce operational capability, and maintain surge capability (contingent on constant policy choices). Thus, between Figure 3 and Figure 4, the user can test variation in the CONOPS, utilization, and integration.

Figure 5 presents a further shift by moving two AC units into the most expensive category of unit: "deployed" (permanently deployed without unit rotation). Deployed units generate both costs and operational capability—they are treated as permanently deployed and generate cost as if operating in a constant high training and operations footing (combat). This adds significant cost, increases presence by one for each unit, and shrinks the region, moving the region upward and to the right.

It follows in Figure 5 that Point A appears further to the right than in Figure 3 or Figure 4. Additionally, despite the inclusion of four strategic units, the maximum cost of the community approaches the maximum cost from Figure 3. Similarly, Point B has shifted upward and to the right, as the lower bound on both cost and capability has increased significantly. Note the baseline community no longer appears in the center of the region: this is because two units are permanently deployed, and never only available. In general, increasing the percentage of "deployed" will add cost, add deployed operational capability (actual presence), and maintain surge.

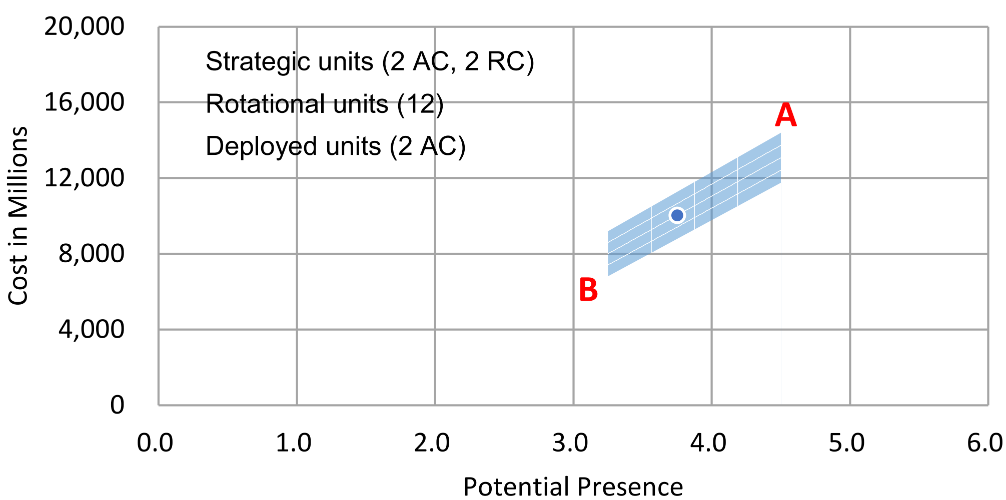

Figure 5. Rotational Force Structure with Fixed Strategic and Deployed Units (16 Units)

In order to present information regarding the impact of certain inputs and assumptions, the tool provides sensitivity to community size. Specifically, the user may add and subtract units from the baseline force structure to construct alternative force sizes. Returning in Figure 6 to only rotational units, as in Figure 3, four units have been added and four units subtracted from the baseline 16-unit community (25 percent changes in force size). This generates force structures of twelve (orange) and twenty (yellow) units respectively. In this case, because the force mix—in terms of unit type and set of input assumptions—has not changed, the shape and slope of the comparative regions has not changed.

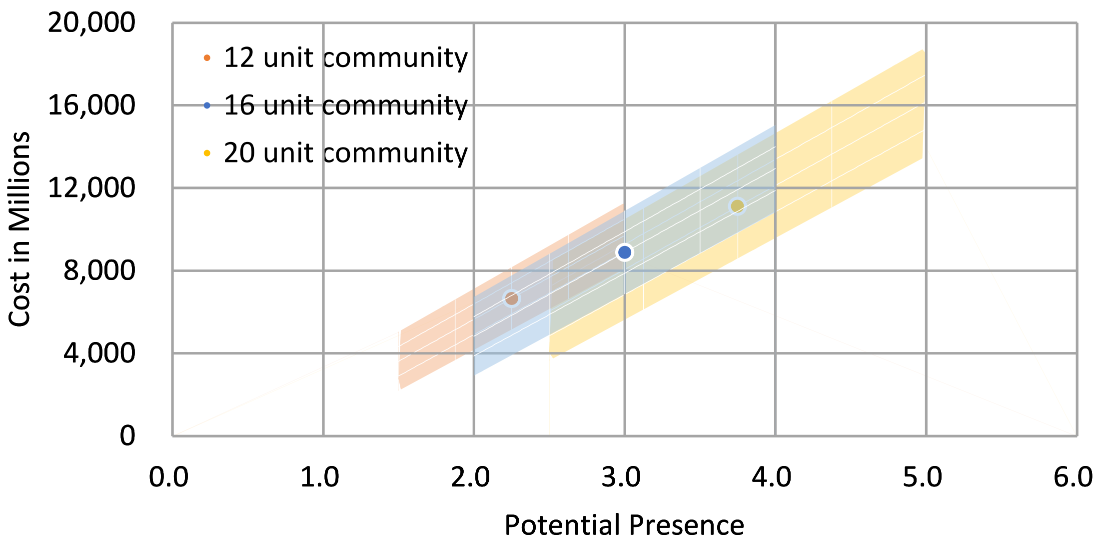

Figure 6. Sensitivity to Changes in Force Size (12, 16 and 20-Unit Communities)

The alternative regions represent scaled up and scaled down force structures. The larger yellow region represents a rotational force 25 percent larger than our illustrative 16-unit case; the smaller a rotational force 25 percent smaller than the baseline case.

These figures provide a better understanding of the options available to a decision maker. For example, a needed level of potential presence may be provided at less cost by a more RC-intensive force that also provides greater surge capability. The figures show that for all rates of deployment, larger force structures can produce equal presence, at a lower cost, while also providing greater strategic capacity. This observation is common with many force structures, but not close to universal. Also from the figures, we can see that a smaller, AC-intensive force structure may be preferred when surge requirements do not greatly exceed the need for potential presence. Figure 3 and Figure 6 are the focus of the analyses in the following individual Service chapters.

2. Army Modeling

A. Introduction

This chapter describes the Army modeling and supporting tool. It starts with a description of data sources in Table 2. This is followed by sections on the major cost elements, assumptions, and user inputs—selection of the community being analyzed, determination of force size and mix, definition of training and operational patterns, resourcing, setting of personnel and equipment cost assumptions, and treatment of indirect cost factors. The chapter concludes with a discussion of the primary Army modeling outputs.

B. Data Sources

Table 2. Primary Army Data Sources

Category	Source
Personnel	OSD
Equipment Operations and Maintenance	Army Cost & Economics
Procurement	Army Cost & Economics
Indirect	FYDP
Deployment	IDA COST Army Cost & Economics

C. Using the Model

Users must specify inputs to define the force-structure alternatives to be analyzed. The tool is constructed initially using Microsoft Excel and includes the following primary elements:

- Model inputs—items that the user can change—appear as blue text
- Locally calculated values—most using model algorithms—appear as black text
- Linked calculated values appear as green text
- Important intermediate output—derived operational factors—appears as red text
- Primary output—cost and capability—appears as gray-on-gray text
- Explanatory text appears in gray

1. Selecting Unit Type

Figure 7 displays the unit selection portion of the Army tool.

Unit Selection	
Element	Combat
Unit Type	Armored Brigade Combat Team (ABCT)
Unit	87300G400 - HEAVY BRIGADE COMBAT TEAM (HBCT)

Figure 7. Unit Selection Portion of Army Tool

Users make choices in three categories. First, the user selects the kind of force-structure **Element** being addressed. A drop-down menu provides four element choices: Aviation, Command, Combat, and Support. Second, the user selects a **Unit Type**. For example, if one chooses the combat element, the **Unit Type** drop-down list contains nine unit types: Chemical, Field Artillery, Infantry, Special Forces, Air Defense Artillery, Stryker Brigade Combat Team (SBCT), Battlefield Surveillance Brigade, Infantry Brigade Combat Team (IBCT), and Armored Brigade Combat Team (ABCT). Third, the user must select a particular **Unit** within the unit type. The **Unit** drop-down menu offers units at various echelons. For example, if the ABCT unit type is selected, one may then choose an entire brigade or any portion of the brigade at the Standard Requirement Code (SRC) level. Overall, roughly 3,000 kinds of units at the SRC level are available for analysis. The echelon that is or is not selected depends on the nature or goal of the costing problem that the user is designing.

2. Selecting the Force Size and Mix Alternatives

Once the user selects the type of unit being analyzed, they must specify the force structure of the initial force-mix alternative in terms of how many units are in the Active, Reserve, and National Guard Components. This involves choosing the number of AC and RC units and deciding how to distribute them among several options with regard to routine use. Additional force-mix alternatives can be selected later for any number of further analyses. Plus/minus columns provide the user the option of varying the force size for the selected unit type positively or negatively by a selected percentage. This functionality adds limited sensitivity referred to as a "range of alternatives." Figure 8 displays the force-structure portion of the Army tool.

Units	**AC Units**	+/-	**RC Units**	+/-	**NG Units**	+/-
Strategic	2	0%	0	0%	2	0%
Available	2	50%	0	50%	2	50%
Rotating	2	50%	0	50%	2	50%
Deployed	2	0%	0	0%	2	0%
Unit Total	8		0		8	

Figure 8. Force-Structure Portion of the Army Tool

To truly cost and compare the tradeoffs of selected force-mix alternatives, various CONOPSs should be considered. In designing various CONOPSs for a given alternative, the user should enter the number of Active, Reserve, and National Guard units desired in this particular force-mix alternative into four categories that imply different levels of operational use—Strategic Units, Rotational Units,(both Available and Rotating), and Deployed Units. Rotational units go through a cycle of preparing to be available for deployment. Sometimes this culminates in deployment and sometimes not. The user must specify the fraction of cycles that available units are expected to deploy by choosing the distribution of available and rotating units. Deployment involves significant additional costs. After the end of the availability or deployment period, rotational units typically go into a rest phase, followed by one or more phases of increased levels of training and readiness.

Deployed units are those permanently located outside of CONUS in an operational environment and incur costs up to a typical "long war" environment. Both AC and RC units may be categorized as forward deployed; however, permanently deployed RC units are unlikely. That noted, RC forward deployed units could conceivably be maintained through a system of individual replacements. Users will probably want to provide deployed units with relatively high resource and activity levels as described in Section 2.C.5, "Setting Resource and Activity Levels."

Strategic units are at home station and do not prepare for rotational deployments. They operate at a steady-state level of resourcing without a phase structure and may represent the minimum resource level for a unit. Either Active or Reserve units may be categorized as strategic. Users will likely want to provide strategic units with relatively low resource and activity levels as described in Section 2.C.5, "Setting Resource and Activity Levels."

3. Setting Dwell and Deployment Phase Structure for Rotational Units

Establishing one or multiple phase structures for rotational units is a central element in determining how much deployed presence can be generated from a given force-structure alternative. This is true for Active, Reserve, and National Guard units. The periods during which units are not mobilized or deployed are termed "dwell." The dwell versus deployment ratios are often a function of policy; however, the tool allows the user to experiment with different force phasing cycles to see the cost, operational capability, and stress impacts of phase variation. To adjust the training phases, users can specify up to five separate dwell phases, entering the number of months in each phase. Often, after a deployment or period of availability, a rotational unit will go into a reset or low-readiness phase followed by one or greater higher readiness phases (dwell 2, dwell 3, etc.) while preparing for the next availability or deployment period. Thus, the tool provides the flexibility to customize various training phases during dwell in preparation for availability or deployment. In this regard, the tool allows the testing of potential alternative training strategies and the associated impact on cost.

Figure 9 shows the tool's entry screen for specifying the rotational pattern in both dwell and deployment portions of the phase cycle for Active units. The entry screen for Reserve and National Guard units is identical to that for Active units.

Active Units			**Months**
Strategic			48
Dwell 1			6
Dwell 2			12
Dwell 3			12
Dwell 4			6
Dwell 5			0
Dwell			36
Mob 1		Bog	12
Mob 2		Bog	0
Mob 3		Bog	0
Mob		1:3.0	12
Bog		1:3.0	12
Available			48
Rotational		Mob 1	48
Deployed	24	Bog	48
			0

Figure 9. Specification of Phase Structure for Rotational Units

Users can specify up to five separate dwell phases, with varying levels of readiness and resourcing to accommodate effectively an infinite number of possible dwell patterns. Tiered, rotational, and constant readiness operational concepts are possible. The deployment period can be divided into up to three phases, which may be used to model a deployment. They may also be used to model pre-deployment training, post-deployment training, transit time, and unit overlap time. The user can specify which phases in the deployment period contribute to operational capability by setting the "BOG" (Boots-on-Ground) duration. A "MOB" (mobilized but not deployed) setting does not contribute to operational capability. Any period during the availability period that is not categorized as "BOG" is "MOB."

No phase structure is required for strategic or deployed units, since their resource and readiness levels are assumed to be constant. A strategic unit may be considered to operate at the minimum level of resourcing and a deployed unit at the maximum, but specific resourcing decisions are up to the user. The phase duration for strategic and deployed units is displayed as the sum of all the phases for rotational units, for consistency purposes. AC and RC forces are handled separately.

4. Defining the Mix of Active and Reserve Component Personnel

For both Active and Reserve units, the user can specify the proportion of billets in a unit filled by Active personnel. This is especially necessary for Guard and Reserve units, most of which have both Full Time Support and Selected Reservists. It could also apply when experimenting with new concepts such as blended units, much like associate units in the Air Force. Figure 10 shows the input area for equipment and procurement. The bottom two rows address the personnel mix. The first of these two rows specifies the proportion of personnel in the unit who are Active; the remainder is in the RC (our cost factors do not distinguish between the cost of Reservists and Guard personnel). The last row specifies the fraction of reservists who are military technicians, personnel who serve as full-time civilians when they are not on Reserve status. The costs of the military technicians are estimated appropriately.

Equipment and Personnel	
Procurement Strategy	Auth
Equipment Life in Years	30
Include Ammunition	Yes
Annual Depot Rate	0%
Equipment Modification Rate	1%
Active Personnel	100%
Miltech Personnel	0%

Figure 10. Setting the Proportion of Personnel Who Are Active and Military Technicians

5. Setting Resource and Activity Levels

Figure 11 shows the structure for specifying the resource and activity levels for strategic units, rotational units, and deployed units in each phase of the rotational cycle. Active, Reserve, and National Guard units must each be addressed separately. User input may be provided for four kinds of resources: personnel (Active Personnel and Reserve Personnel), operating and maintenance activities captured by the activity level (Activity), equipment (Equipment), and indirect costs (Indirect).

Resource levels can be specified for both AC and RC personnel in all units, regardless of the unit's Component. Entries should be made as desired for all rotational phases and for strategic and deployed units.

Active Units		Months	Active Personnel			Reserve Personnel			Activity		Equipment		Indirect	
Strategic		48	-10%		3,735	-10%		0	1.0		-10%		-10%	
Dwell 1		6	0%		4,150	0%		0	0.8		-10%		0%	
Dwell 2		12	0%		4,150	0%		0	0.9		-5%		0%	
Dwell 3		12	0%		4,150	0%		0	1.0		-5%		0%	
Dwell 4		6	0%		4,150	0%		0	1.5		0%		0%	
Dwell 5		0	0%		4,150	0%		0	1.0		0%		0%	
Dwell		36	0%			0%			1.0		-5%		0%	
Mob 1	Bog	4	0%		4,150	0%		0	3.5		0%		0%	
Mob 2	Bog	4	0%		4,150	0%		0	3.5		0%		0%	
Mob 3	Bog	4	0%		4,150	0%		0	3.5		0%		0%	
Mob	1:3.0	12	0%			0%			3.5		0%		0%	
Bog	1:3.0	12	0%			0%			3.5		0%		0%	
Available		48	0%			0%			1.6		-4%		0%	
Rotational	Mob 1	48	0%	0%	4,150	0%	0%	0	1.6	3.5	-4%	0%	0%	0%
Deployed	24 Bog	48	0%		4,150	0%		0	3.5		0%		0%	
		0	0%			0%			1.0		0%		0%	

Figure 11. Setting Resource and Activity Levels

The default setting for Active and Reserve personnel levels—indicating zero deviation from the Army-specified level of personnel for a fully resourced unit—is 0 percent. Entering a new number causes the calculation of personnel costs to change by the specified percentage. Entering a positive or negative number increases or decreases personnel and personnel costs by the indicated percentage, respectively. After a unit returns from deployment, members of the unit may leave for a variety of reasons—their enlistment has ended, they may be reservists temporarily attached to an Active unit, they may be sent to school, or they may be reassigned. Therefore, it is reasonable to account for units that may not be fully manned. Also, units may be manned to higher levels during periods when higher readiness must be achieved. This variation in unit manning as a unit cycles through phases can be based on actual experience, or by design of the user for experimentation purposes or for an estimate of innovative manning strategies. For example, additional training staff may be provided. This is where custom design of up to five dwell phases and three mobilization phases can be applied.

The treatment of equipment and indirect costs is similar to that of personnel. The default level of 0 percent for equipment indicates that the quantity of equipment on hand is that specified in the organization's TOE. This allows the user to experiment with various innovative equipping strategies for cost impacts. During dwell periods, total equipping of less than 100 percent is likely. The default level of 0 percent for Indirect indicates that the unit generates a typical amount of indirect cost during that phase. For strategic units that never deploy, total equipping may never reach 100 percent in any phase (until called for maximum surge or mobilization). Changing the amount of equipment on hand adjusts the amount of equipment used in training activity and thus affects operating costs. Changing the amount of equipment may also have an impact on procurement costs. Changing the amount of indirect resources affects indirect operating costs by adding or subtracting a fixed percentage across the category of indirect costs.

The activity level indicates how much a unit is training or operating relative to its normal or peacetime state. The default setting for activity level is 1. This is assumed to be the normal non-deployed level of activity for a fully ready unit. The user may enter a lower or higher number to indicate lower or higher OPTEMPO. This level drives pay for units in the RC—higher activity increases RC training days relative to normal—as well as operating costs and equipment replacement costs. Operating costs during the specified phase are modified according to the factor entered. Operating costs depend on both the amount of equipment on hand and the activity level.

6. Choosing Equipment Assumptions

Equipment and ammunition replacement costs are affected by Procurement Strategy, Equipment Life in Years, Ammunition Replacement, Annual Depot Rate, and the Equipment Modification Rate. These inputs are specified in "Equipment and Personnel," to the right of "Resource and Activity Levels." Being able to incorporate equipment life, depot maintenance, and modernization enables the tool to handle multi-year analysis more broadly. It provides a much truer picture of all costs for a selected community over the lifetime of the unit. Figure 12 displays the structure for specifying equipment replacement cost inputs. For example, if the user does not want to include the cost of munitions, the user would set **Include Ammunition** to "No." If the **Equipment Life in Years** is adjusted from 30 to 20 or 40 years the procurement costs will change.

Equipment and Personnel	
Procurement Strategy	Auth
Equipment Life in Years	30
Include Ammunition	Yes
Annual Depot Rate	0%
Equipment Modification Rate	1%
Active Personnel	100%
Miltech Personnel	0%

Figure 12. Setting Equipment Replacement, Ammunition, Depot, and Modification Inputs

Procurement Strategy is selected from a drop-down menu containing the choices "Auth" (Authorized), "Avail" (Available), or "None." "Auth" assigns replacement cost directly to the unit for all equipment a unit is authorized to have, "Avail" only assigns replacement cost to equipment on hand with the unit, and "None" excludes equipment replacement costs from our calculations, under the implicit assumption, if made by the user, that it is not a function of force-mix decisions. The "Avail" setting allows the percentage of equipment assigned to a unit during each of the eight phases to drive the replacement cost, again allowing for flexibility in innovative equipping strategies.

Equipment Life in Years is the time in years over which equipment will be replaced, on average. The tool assumes a 1.0 activity level represents one year of equipment replacement as the default for the selected procurement strategy. The entry in the **Equipment Life in Years** input affects the rate at which equipment is replaced, and therefore the equipment replacement costs. Therefore, if there is a fiscally constrained environment and procurement profiles are reduced (or if the user wanted to see the impact of a reduction), the equipment life in years could be increased.

The user may choose whether or not to include ammunition in procurement costs in the third input field under **Equipment and Personnel** (**Include Ammunition**). Ammunition costs are a function of equipment resourcing and the activity level. Including ammunition will change the total annual procurement costs. The user may then specify an **Annual Depot Rate**. This is the percentage of the unit's typical post-deployment reset cost—the cost to reset the entire unit—used to estimate a unit's normal depot maintenance cost. This is set to 0 percent by default and should not be adjusted unless reasonable alternative information is available.

Equipment Modification Rate_is the final input field related to equipment operating and replacement costs. It indicates the percentage of the total acquisition cost of the unit necessary to fund typical O&M-funded modifications. It funds both hardware and software modifications. This is typically between 0 percent and 5 percent on an annual basis and is included in O&M costs. This could be set to reflect actual experience or could be used in sensitivity analysis to estimate the impact of increasing or decreasing the modernization efforts in a selected community.

7. Modeling Indirect Costs

Indirect cost factors—such as Installation Support, Personnel Administration, Personnel Benefits, Medical Care, and General Training and Education—can be specified by the user. Figure 13 displays the area where **Indirect Factors** are set.

Indirect Factors	
Installation Support	50%
Personnel Administration	50%
Personnel Benefits	50%
Medical Care	50%
General Training and Education	50%

Figure 13. Indirect Costs

Currently, the majority of indirect costs are based on three years (2009–2011) of historical spending from the FYDP. They are updated annually on a rolling basis. Indirect costs are calculated as the cost per person for the AC or as the cost per effective FTE for the RC. The inputs shown in Figure 13 set the percentage of the total indirect costs that will be treated as marginal with changes in the force structure. The default assumption within the tool, sometimes used within DoD, is to set indirect costs as 50 percent variable with changes in personnel. For example, a 10 percent reduction in AC personnel will, according to the accounting rules described herein, reduce "Installation Support" by 5 percent for the AC.

There are many factors that may be relevant when determining the portion of indirect costs—and all costs—that change with changes in force structure. A selection of factors relevant to indirect costs might include any or all of the following:

- Timeframe of the analysis,
- Magnitude of the change in force structure,
- Category of indirect cost element (five in our tools), and
- Type of unit or manpower driving the change.

A relevant issue here is the timeframe of the analysis—the duration over which the modeling results will be applied. Consider for example how cost savings will differ in the short-term and long-term due to force-structure reductions. For a short timeframe, only direct costs are likely to change: personnel costs, equipment operating costs, and limited procurement costs. It is not likely indirect costs would change to the same magnitude, if at all. As the timeframe of the analysis increases, direct costs would continue to be affected; however, an increasing portion of indirect costs would likely be affected as well. Taken to the extreme, permanent long-term reductions in force structure may generate marginal changes in indirect costs approaching 100 percent variable. In this case, the user may choose to select all indirect costs as 100 percent variable.

8. Including Other Costs

Other costs include special training events, modernizations, transition hurdles, prepositioning stocks, and other similar undertakings. These costs cannot be easily integrated into a simple tool, and are not reliably estimated using averages. They may, however, be worth including if they are well known or the user would like to experiment with alternative unit costs. Thus, this function can be used as a "catch all" in order to capture additional, alternative, or unique costs. It is up to the user to identify and input these events. As shown in Figure 14, these costs can be a function of almost any cost driver; e.g., the number of personnel, the unit type, or the duration of the phase cycle.

Description	Scenario	Unit	Personnel	Phase	Metric	Value
Event 1	Default	Strategic	N/A	N/A	$/Unit	0
Event 2	Default	Strategic	N/A	N/A	$/Unit	0
Event 3	Default	Strategic	N/A	N/A	$/Unit	0
Event 4	Default	Strategic	N/A	N/A	$/Unit	0
Event 5	Default	Strategic	N/A	N/A	$/Unit	0
Event 6	Default	Strategic	N/A	N/A	$/Unit	0
Event 7	Default	Strategic	N/A	N/A	$/Unit	0
Event 8	Default	Strategic	N/A	N/A	$/Unit	0
Event 9	Default	Strategic	N/A	N/A	$/Unit	0
Event 10	Default	Strategic	N/A	N/A	$/Unit	0

Figure 14. Other Costs

Accounting for these possibilities in a tool makes it simple to add extra costs. A modeler should consider factors such as the type of unit, the CONOPS, the cost-driving metric, and cost factor source, when adding other costs. Allowing alternative possibilities to be considered when modeling unit costs provides important flexibility. For example, a unit that must report to a training center before it deploys may require an additional per person cost during its final dwell phase. The **Other Costs** functionality could be used to handle such a unit-specific requirement.

D. Standard Outputs

1. Introduction

This section discusses the primary outputs the tool produces. The figures and tables are based on a specific set of inputs and assumptions chosen for this particular analysis. We have selected a typical Army IBCT for this notional analysis. In this case, we assume the force structure only includes AC and National Guard Component units. The initial force structure includes the set of characteristics and assumptions shown in Table 3.

Table 3. Notional Army Community

IBCT	Active Component		National Guard Component		Total
	Quantity	Range of Alternatives	Quantity	Range of Alternatives	
Strategic	0	+/-0%	0	+/-0%	0
Available	8	+/-25%	8	+/-25%	16
Rotating	8	+/-25%	8	+/-25%	16
Deployed	0	+/-0%	0	+/-0%	0
Total	**16**	**+/- 25%**	**16**	**+/- 25%**	**32**

Note: Assumes ~3,500 Soldiers per Brigade.

Key inputs to the tool include Active and National Guard phases, BOG-to-dwell ratios, MOB-to-dwell ratios, resourcing levels, and activity levels. These appear in the tool as shown in Figure 11 and Figure 15. Settings for this analysis include:

- Active BOG-to-dwell of 1:3 and Guard MOB-to-dwell of 1:5 (BOG-to-dwell 1:7)
- Deployed activity rate of 3.5 for the AC and 4.0 for the Guard (Guard higher when deployed due to lower non-deployed activity rate)
- Increased Indirect Costs during mobilization and deployment for RC units (additional costs associated with deployed installations)
- Equipment replacement over 30 years at the authorized level
- Included ammunition procurement linearly variable with the activity rate
- Indirect costs variable at 50 percent with the number of personnel

Guard Units		Months	Active Personnel			Reserve Personnel			Activity		Equipment		Indirect	
Strategic		72	-10%		374	-10%		3,361	1.0		-10%		-10%	
Dwell 1		12	0%		415	0%		3,735	1.0		-10%		0%	
Dwell 2		24	0%		415	0%		3,735	1.0		-10%		0%	
Dwell 3		12	0%		415	0%		3,735	1.0		-5%		0%	
Dwell 4		12	0%		415	0%		3,735	1.5		0%		0%	
Dwell 5		0	0%		415	0%		3,735	1.0		0%		0%	
Dwell		60	0%			0%			1.1		-7%		0%	
Mob 1	Mob	2	0%		415	0%		3,735	2.0		0%		+10%	
Mob 2	Bog	9	0%		415	0%		3,735	4.0		0%		+10%	
Mob 3	Mob	1	0%		415	0%		3,735	2.0		0%		+10%	
Mob	1:5.0	12	0%			0%			3.5		0%		+10%	
Bog	1:7.0	9	0%			0%			4.0		0%		+10%	
Available		72	0%			0%			1.5		-6%		+2%	
Rotational	Mob 1	72	0%	0%	415	0%	0%	3,735	1.3	2.0	-6%	0%	+2%	+10%
Deployed	24 Bog	72	0%		415	0%		3,735	4.0		0%		+20%	
		12	0%			0%			1.0		0%		0%	

Figure 15. National Guard Component Resourcing and Activity Levels

2. Force Structure Cost and Rotational Capability

Combining the chosen force structure with the selected inputs produces an estimate of two major factors: cost and operational capability. This estimate appears in Table 4. Cost is reported in millions of dollars per year with both cost and capability appearing by unit category and in total. The selected force structure of 32 brigades costs in total $12.79 billion in Fiscal Year (FY) 2012 dollars on an annual basis.

Table 4. Notional Army Community Cost and Capability

SBCT	Active Component				National Guard Component			
	Qty	Cost	Max BOG	BOG	Qty	Cost	Max BOG	BOG
Strategic	0	0	0.00	0.00	0	0	0.00	0.00
Available	8	4,015	2.00	0.00	8	977	1.33	0.00
Rotating	8	5,567	2.00	2.00	8	2,235	1.33	1.00
Deployed	0	0	0.00	0.00	0	0	0.00	0.00
Total	**16**	**9,582**	**4.00**	**2.00**	**16**	**3,212**	**2.66**	**1.00**

The "Max BOG" is the potential BOG, on an annual basis, generated for all AC and RC units. "BOG" is the portion of the "Max BOG" generated by units that are actually deployed, given the assumptions made about the portion of rotational units that deploy when they become available. Table 4 shows the specified 32-unit force structure generating a total of 3.00 BOG years on an annual basis. The 16 "rotating" units generate the full 3.00 units of BOG. If "deployed" units were also included in the notional community, each would generate one year of additional BOG. Although not deployed during their available period, the "available" units provide an additional 3.33 units of potential BOG, equal to the maximum potential BOG of the "rotating" units that deploy.

3. A Graphical Display of the Community and a Range of Alternatives

This section presents sample graphs for the chosen force structure and a range of potential alternatives. We show the output in the same manner as the figures in the Introduction chapter. The specific alternative described earlier appears as a (blue) point in Figure 16. The figure additionally provides a sensitivity analysis varying the AC-RC mix of rotational units and the rate at which available units are deployed. Increasing the percentage of AC units increases costs and increases operational presence. Increasing the rate at which units deploy increases costs and consumes available operational presence.

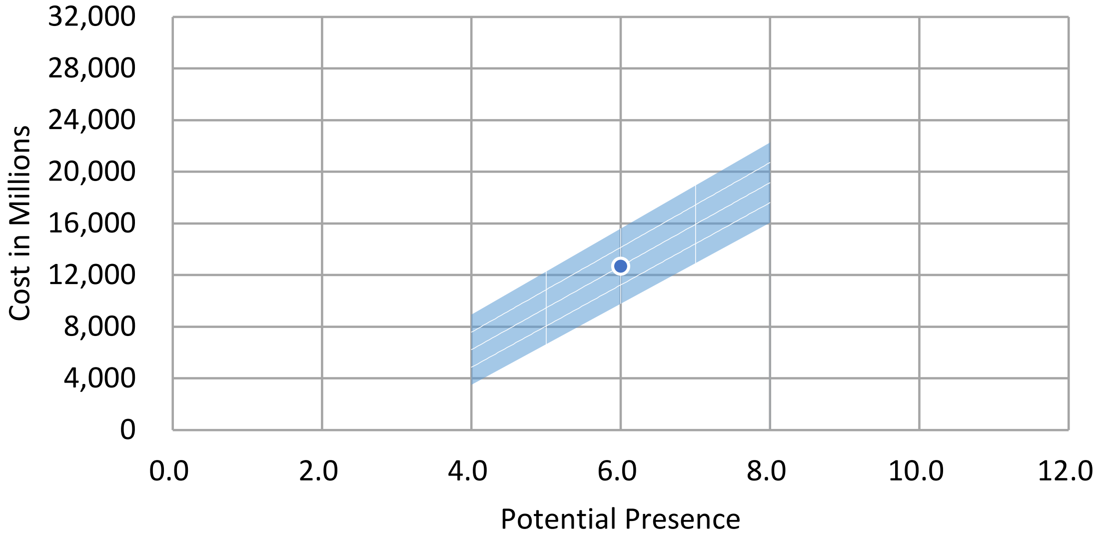

Figure 16. Point Estimate and Rotational Alternatives (32 Units)

The illustrative force structure generates between 4.0 and 8.0 units of potential operational presence, at a cost of between approximately $3,900 million and $21,900 million per year. In years with a high deployment requirement, costs might increase 100 percent for RC-heavy force structures relative to years where there is no deployment demand. For AC-heavy force structures, this cost increase may be as high as 40 percent. The range between the bottom and top of the region illustrates this difference in cost. Specifically, at the bottom, all units never deploy during periods of availability; at the top, all units always deploy during all periods of availability.

Complementing our analysis of the regions introduced earlier, we consider the same for the selected force structure:

- Bottom, left – all rotational RC units, trained and never deployed
- Bottom, right – all rotational AC units, trained and never deployed
- Top, left – all rotational RC units, trained and deployed when available
- Top, right – all rotational AC units, trained and deployed when available

Joining these discrete points forms the region in Figure 16. Changing the force mix and CONOPS by adding or subtracting strategic or deployed units would shift the region, but would not alter its basic shape. No such units are considered here.

Figure 17 expands on Figure 16 by including two potential alternative force structures that add and remove eight rotational units each. The (orange) region includes all possible 24-unit force structures (given our assumptions) and the (yellow) region includes all possible force structures of 40 units (given our assumptions). These alternatives reflect the entries selected for the “Range of Alternatives” in Table 3.

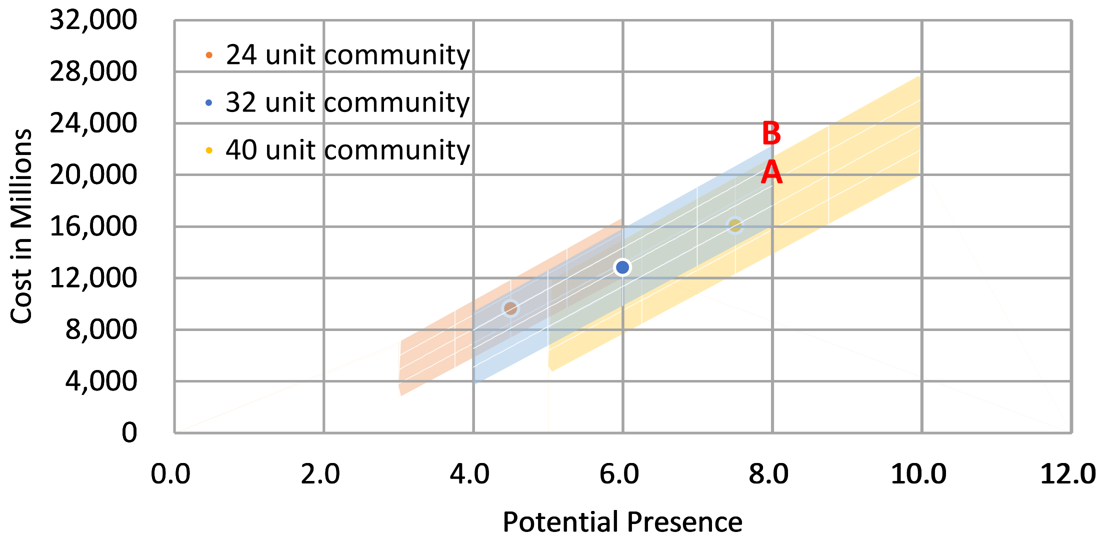

Figure 17. Sensitivity to Changes in Force Size (24, 32, and 40-Unit Communities)

For this case, larger force structures with higher percentages of RC units can provide a given level of potential presence with increased strategic capability for similar costs to those of smaller force structures. This point is clearly presented in Figure 17 by shifting the community structure from point B of the 32-unit community to point A of the 40-unit community. The community generates equal potential presence, deploys during all available periods and provides greater strategic capability. Additionally, consider point A that falls in two of the three regions representing two alternative mixes: the first, a 40-unit 60 percent AC community (yellow), and the second, a 32-unit 100 percent AC community (blue). Each alternative generates approximately eight units of potential presence; however, the larger RC-intensive community deploys eight units per year while the smaller AC-intensive community only between six and seven. The forces are of equal cost; however, the yellow force mix provides an additional eight units of strategic capacity. Cost savings with RC-intensive forces are highest during periods of low deployment activity. Importantly, the RC-heavy force structures thus provide greater opportunity for cost savings than the AC-heavy forces, if the need for deployment decreases.

Finally, we provide an experimental excursion to improve experience with the factors driving the analysis. Figure 18 presents this relatively extreme additional case.

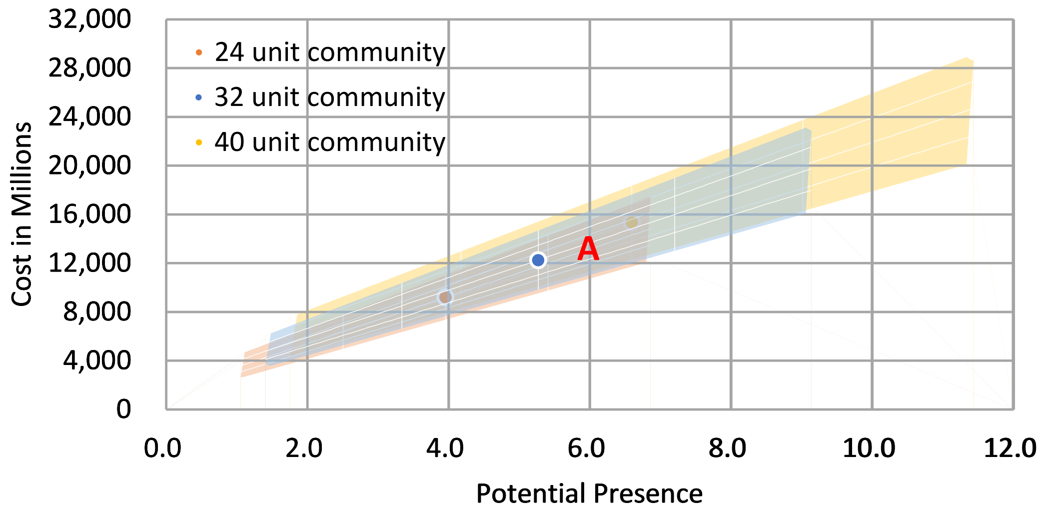

Figure 18. Alternative Rotational Pattern Excursion (24, 32, and 40-Unit Communities)

Figure 18 shows an alternative with the same 24, 32, and 40-unit communities but a shift in rotational policy. The AC deploys at a BOG-to-dwell of 1:2.5 and the RC mobilizes at a MOB-to-dwell of 1:12.0 and a BOG-to-dwell of 1:21.8. Larger RC-heavy force structures no longer offer a lower cost for a given level of potential presence. In fact, the regions have flipped and larger RC-heavy force structures cost more than smaller AC-intensive structures for a given level of rotational presence. The larger communities, however, still provide greater strategic presence.

Point A compares all three communities with deployable capacity of six units—the AC-intensive force of 24 units (orange), the slightly AC-intensive force of 32 units (blue), and the slightly RC-intensive force of 40 units (yellow). The visible difference in slope between the bottom and top lines is a result of the vastly different rotation policy between the Components. The RC effectively operates as a near-permanent strategic reserve in this scenario. If there is demand for larger total force levels at a reasonable additional cost, such a force mix may be desirable. The wider range of the regions represents the increased rate of reduction in operational capability when forces are shifted from Active to Reserve status. The tool is designed to inform this type of simple capability excursion by producing data-intensive but necessary estimates of cost.

3. Marine Corps Modeling

A. Introduction

This chapter describes the Marine Corps methodology and supporting tool. It starts with a description of data sources and treatment in Table 5. This is followed by sections on the major cost elements, assumptions, and inputs to the tool—selection of the community being analyzed, determination of force size and mix, definition of rotational patterns, deployment distances, resourcing, setting of assumptions underlying the calculation of equipment costs, and treatment of indirect cost factors. The chapter concludes with a discussion of the primary Marine Corps modeling outputs.

B. Data Sources

Table 5. Primary Marine Corps Data Sources

Category	Source
Personnel	OSD
Equipment Operations and Maintenance	Total Force Structure Management System (TFSMS) Navy Visibility and Management of Operating and Support Costs (VAMOSC) Army Cost & Economics
Procurement	Marine Corps Program Analysis & Evaluation (PA&E)
Indirect	FYDP
Deployment	IDA COST Marine Forces Command (MARFORCOM)

C. Using the Model

A user must specify many inputs to define the force structure cases to be analyzed, and can design several different force-mix alternatives for analysis. Different CONOPS and procurement strategies can be tested in the alternatives. The goal of cost is to seek an acceptable force structure that is closer to optimal efficiency in cost operational capability and strategic capacity. Model force structure alternatives are constructed initially using Microsoft Excel and include the following elements:

- Model inputs—items that the user can change—appear as blue text
- Locally calculated values—most using model algorithms—appear as black text
- Linked calculated values appear as green text

- Important intermediate output—derived operational factors—appears as red text
- Primary output—cost and capability—appears as gray-on-gray text
- Explanatory text is shown in gray

1. Selecting Unit Type

Figure 19 displays the unit selection portion of the Marine Corps tool.

Unit Selection	
Element	GCE
Unit Type	GCE-Infantry
Unit	INFANTRY REGT, MARDIV

Figure 19. Unit Selection Portion of Marine Corps Tool

To begin designing a force-mix alternative, users must make choices in three categories. First, the user selects the kind of force structure **Element** being addressed. A drop-down menu provides four element choices: Aviation Combat Element (ACE), Command Element (CE), Ground Combat Element (GCE), and Logistics Combat Element (LCE). Second, the user selects a **Unit Type**. For example, for the GCE element, the **Unit Type** drop-down list contains eleven unit types: Artillery, Combat Engineer, Command Headquarters, Communications, Direct Support, Light Armored Reconnaissance, Reconnaissance, Special Operations Force, Tracked Vehicles-Tanks, Tracked Vehicles-Assault Amphibious Vehicles (AAVs), and Transportation. Third, the user must select a particular **Unit** within the unit type. The **Unit** drop-down menu offers units at various echelons. For example for Infantry, one may choose an Infantry Regt, Headquarters and Support (H&S) Company, Infantry Battalion, Rifle Company, or Weapons Company. Overall, roughly 200 kinds of units at the Unit-Type Code (UTC) level are available for analysis. This set of units changes with time and should be updated, at a minimum, on an annual basis.

2. Selecting the Force Size and Mix Alternatives

Once the user selects the type of unit being analyzed, they must specify the force structure or force mix in terms of how many units are in the Active and Reserve Components. This involves choosing the number of AC and RC units and deciding how to distribute them among several options with regard to routine use. When designing multiple force-structure or force-mix alternatives for comparison, this selection is key to the scope of the set of alternatives. Plus/minus columns provide the user the option of varying the force size for the selected unit type positively or negatively by a selected percentage. This functionality adds limited sensitivity referred to as a "range of alternatives." Figure 20 displays the force-structure portion of the Marine Corps tool.

Units	Active Component Units		Reserve Component Units	
Strategic	1	0% +/-	1	0% +/-
Available	1	50% +/-	1	50% +/-
Rotating	1	50% +/-	1	50% +/-
Deployed	1	0% +/-	1	0% +/-
Unit Total	4		4	

Figure 20. Force Structure Portion of Marine Corps Tool

The number of Active and Reserve units must be entered in four primary categories that imply different variations of operational use—Rotational Units (both Available and Rotating), and Non-Rotational Units (both Strategic and Deployed). Rotational units go through a cycle of preparing to be available for deployment. Sometimes this culminates in deployment and sometimes not. Thus, when designing a force structure each alternative should have a stated CONOPS regarding force employment. The user must specify the fraction of cycles that available units are expected to deploy by choosing the distribution of available and rotating units. The number of future deployments may not be known; thus, alternatives with multiple deployment assumptions can be run for cost comparisons. Following the end of the availability or deployment period, rotational units typically go into a rest phase, followed by one or more phases of increased levels of training and readiness.

Deployed units are those permanently located outside CONUS engaged in operations and that incur costs up to those typical of an extended contingency. Both AC and RC units may be categorized as deployed; however, permanently deployed RC units are unlikely. That noted, RC forward deployed units could conceivably be maintained through a system of individual replacements. Users will likely want to provide deployed units with relatively high resource and activity levels as described in Section 3.C.5, "Setting Resource and Activity Levels."

Strategic units are at home station and do not prepare for rotational deployments. They do not contribute to "day-to-day" operational capability, but would usually be used for surge capacity in an escalation of forces. Strategic units primarily contribute to strategic capacity. They operate at a steady-state level of resourcing without a phase structure and may represent the minimum resource level for a unit. Either Active or Reserve units may be categorized as strategic. Users will likely want to provide strategic units with relatively low resource and activity levels as described in Section 3.C.5, "Setting Resource and Activity Levels."

3. Setting Dwell and Deployment Phase Structure for Rotational Units

The phase structure for rotational units is a central element in determining how much deployed presence can be generated from a given force structure or force mix alternative. Cyclic training phase designation applies to both Active and Reserve units and is key to cost and the amount of operational capability a given force structure can produce. The periods during which units are not mobilized or deployed are termed "dwell." Users can specify up to five separate dwell phases, entering the number of months in each phase. The dwell phases are most often cyclic in nature and build toward full availability or deployment of a unit. Often, after a deployment or period of availability, a rotational unit will go into a reset or low-readiness phase, followed by one or greater higher readiness phases (dwell 2, dwell 3, etc.) while preparing for the next availability or deployment period. Thus, the tool provides the flexibility to customize various training phases during dwell in preparation for availability or deployment. In this regard, the tool allows the testing of potential alternative training strategies and the associated impact on cost.

Figure 21 shows the entry screen for specifying the rotational pattern in both dwell and deployment portions of the phase cycle for Active units. The entry screen for Reserve units is identical to that for Active units.

Active Units			**Months**
Strategic			24
Dwell 1			6
Dwell 2			6
Dwell 3			6
Dwell 4			0
Dwell 5			0
Dwell			18
Mob 1		Mob	0
Mob 2		Bog	6
Mob 3		Mob	0
Mob		1:3.0	6
Bog		1:3.0	6
Rotating			24
Available		Mob 2	24
Deployed	24	Bog	24
			0

Figure 21. Specification of Phase Structure for Rotational Units

The dwell period can be divided into up to five distinct phases with varying levels of readiness and resourcing to accommodate effectively an infinite number of possible dwell patterns. Tiered, rotational, and constant readiness operational concepts are possible. The deployment period can be divided into up to three phases. These may be used to model extenuating circumstances of future deployments. In the case of the RC, the deployment phases may be used to model pre-deployment training, rest periods, transit time, unit overlap time, or post-deployment activity. The user can specify which phases in the deployment period contribute to operational capability by setting the "BOG" (Boots-on-Ground) duration. A "MOB" (mobilized but not deployed) setting does not contribute to operational capability. Any period during the availability period that is not categorized as "BOG" is "MOB."

No phase structure is required for strategic or deployed units, since their resource and readiness levels are assumed to be constant. A strategic unit may be considered to operate at the minimum level of resourcing and a deployed unit at the maximum, but specific resourcing decisions are up to the user, including CONOPS and level of activity. Phase structure must be set separately for Active and Reserve units, as they are usually different due to separate rotation policies.

4. Defining the Mix of Active and Reserve Component Personnel

For both Active and Reserve units, the user can specify the proportion of billets in a unit filled by Active personnel. Figure 22 shows the input area for equipment and procurement. The bottom row addresses the personnel mix by specifying the proportion of personnel in the unit who are Active. For RC units, increasing the percentage of Active personnel effectively adds Full-Time Support (FTS) Reserve personnel to the unit. The remainder of personnel would be traditional Selected Reservists, who are usually funded at 39 days per year.

Equipment and Personnel	
Replacement Strategy	Auth
Equipment Useful Life	30
Include Ammunition	Yes
Fuel Price	4.50
Equipment Modification Rate	1%
Active Personnel	100%

Figure 22. Setting the Proportion of Personnel Who Are Active

5. Setting Resource and Activity Levels

Figure 23 shows the structure for specifying the resource and activity levels for strategic units, rotational units, and deployed units in every phase of their rotational cycle. Active and Reserve units must each be addressed separately, as their cycles will mostly likely be different. User input may be provided for four kinds of resources: personnel, O&M activities captured by the activity level, equipment, and indirect costs. Resource levels can be specified for both AC and RC personnel in all units, regardless of the unit's Component.

Active Units		Months	Active Personnel			Reserve Personnel			Activity		Equipment		Indirect	
Strategic		24	-30%		672	-30%		0	0.9		-20%		0%	
Dwell 1		6	-15%		816	-15%		0	1.0		-10%		0%	
Dwell 2		6	-10%		864	-10%		0	1.0		0%		0%	
Dwell 3		6	0%		960	0%		0	1.5		0%		0%	
Dwell 4		0	0%		960	0%		0	1.0		0%		0%	
Dwell 5		0	0%		960	0%		0	1.0		0%		0%	
Dwell		18	-8%			-8%			1.2		-3%		0%	
Mob 1	Bog	0	0%		960	0%		0	2.0		0%		+10%	
Mob 2	Bog	6	0%		960	0%		0	3.0		0%		+10%	
Mob 3	Bog	0	0%		960	0%		0	2.0		0%		+10%	
Mob	1:3.0	6	0%			0%			3.0		0%		+10%	
Bog	1:3.0	6	0%			0%			3.0		0%		+10%	
Rotating		24	-6%			-6%			1.6		-3%		+3%	
Available	Dwell 3	24	-6%	0%	960	-6%	0%	0	1.3	1.5	-3%	0%	0%	0%
Deployed	24 Bog	24	0%		960	0%		0	2.5		0%		+10%	
		0	0%			0%			2.5		0%		0%	

Figure 23. Setting Resource and Activity Levels

The default setting for Active and Reserve personnel levels is 0 percent. This indicates zero deviation from the TOE level of personnel for a fully resourced unit. By entering a new number, the user causes the calculation of personnel costs to change by the specified percentage. Entering a positive or negative number increases or decreases personnel costs by the indicated percentage, respectively. After a unit returns from deployment, members of the unit may leave for a variety of reasons—their enlistments end, they return to inactivated status, they go back to school, or are reassigned. Therefore, it is reasonable to account for units that may not be fully manned in various phases of the cycle. In addition, units may be manned to higher levels during periods when higher readiness is necessary and/or building for deployment. This is where custom design of up to five dwell phases and three mobilization phases can take place as units move through training and deployment cycles.

The treatment of equipment and indirect costs is similar to that of personnel. The default level of 0 percent for equipment indicates that the quantity of equipment on hand is that specified in the organization's TOE. During dwell periods, total equipping less than 100 percent is likely depending on the equipping strategies a user may choose when designing the force structure. Changing the amount of equipment on hand adjusts the amount of equipment used in training and thus affects operating costs. Changing the amount of equipment may also have an impact on procurement costs. Adjustments to equipment resourcing allow for flexibility in testing innovative equipping strategies: sharing of equipment between similar units in different phases and allowing lower on-hand levels of equipment when it is not needed for training. A detailed modeling of equipping strategies would require modification of unit data used to develop operating costs, which is not currently accessible to users. The default level of 0 percent for Indirect indicates that the unit generates a typical amount of indirect cost. This should not be changed in routine use.

The activity level indicates how much a unit is training or operating relative to its normal or peacetime state. The default setting for activity level is 1.0. This is assumed to be the normal level of activity for a fully ready unit. The user may enter a lower or higher number to indicate lower or higher OPTEMPO. Activity levels can be changed as units proceed through the various dwell phases and proceed to deployment. This level drives pay for units in the RC—higher activity increases RC training days—as well as operating costs and equipment replacement costs. Operating costs during the specified phase or for deployed or strategic units are modified according to the factor entered. Operating costs depend on both the amount of equipment on hand and the activity level applied to that equipment.

The availability of eight total phases allows the user to test many alternative training and deployment cycles.

6. Choosing Equipment Assumptions

Equipment and ammunition replacement costs are affected by: Procurement Strategy, Equipment Life in Years, Ammunition Replacement, and the Equipment Modification Rate. These inputs are specified in "Equipment and Personnel" for Active and Reserve units to the right of "Resource and Activity Levels." Figure 24 displays the structure for specifying equipment replacement cost inputs.

Equipment and Personnel	
Replacement Strategy	Auth
Equipment Useful Life	30
Include Ammunition	Yes
Fuel Price	4.50
Equipment Modification Rate	1%
Active Personnel	100%

Figure 24. Setting Equipment Replacement, Ammunition, and Modification Inputs

Procurement Strategy is selected from a drop-down menu containing the choices "Auth" (Authorized), "Avail" (Available), or "None." "Auth" assigns replacement cost for all equipment a unit is authorized to have directly to the unit, "Avail" only assigns replacement cost to equipment on hand with the unit, and "None" excludes equipment replacement costs from our calculations, under the implicit assumption, if made by the user, that it is not a function of force-mix decisions. The "Avail" setting allows the percentage of equipment assigned to a unit during each of the eight phases to drive the replacement cost, again allowing for flexibility in innovative equipping strategies. Units may increase their equipment status as they build through the dwell phases towards "available" or deployment.

Equipment Life in Years is the rate in years over which equipment will be replaced, on average. The tool assumes a 1.0 activity level to calculate one year of equipment replacement as the default for the selected procurement strategy. The entry in the **Equipment Life in Years** input affects the rate at which equipment is replaced, and therefore the equipment replacement costs. Therefore, a shorter equipment service life will increase procurement costs and a longer service life will decrease costs.

The user may choose whether or not to include ammunition in procurement costs in the third input field under **Equipment and Personnel** (**Include Ammunition**). Ammunition costs are a function of equipment resourcing and the activity level. Including ammunition will change the total annual procurement costs.

Fuel prices may be set in the **Fuel Price** input field in dollars per gallon. Once the fuel price is selected, total fuel costs will change with the "Activity" level selections throughout the phases in Figure 23.

Equipment Modification Rate is the final input field related to equipment operating and replacement costs. It indicates the percentage of the total acquisition cost of the unit necessary to fund typical O&M-funded modifications. It funds both hardware and software modifications. This is typically between 0 percent and 5 percent on an annual basis and is included in O&M costs.

7. Modeling Indirect Costs

Indirect cost factors such as Installation Support, Personnel Administration, Personnel Benefits, Medical Care, and General Training and Education can be specified by the user. Figure 25 displays the area where **Indirect Factors** are set.

Indirect Factors	
Installation Support	50%
Personnel Administration	50%
Personnel Benefits	50%
Medical Care	50%
General Training and Education	50%

Figure 25. Indirect Costs

Currently, the majority of indirect costs are based on three years (2009–2011) of historical spending from the FYDP. They are updated annually on a rolling basis. Indirect costs are calculated as the cost per person for the AC, or as the cost per effective FTE for the RC. The inputs shown in Figure 25 set the percentage of total indirect costs that will be treated as marginal with changes in the force structure. The default assumption within the tool, sometimes used within DoD, is to set indirect costs as 50 percent variable with changes in personnel. For example, a 10 percent reduction in AC personnel will, according to the accounting rules described herein, reduce "Installation Support" by 5 percent for the AC.

There are many factors that may be relevant when determining the portion of indirect costs—and all costs—that change with changes in force structure. A selection of factors relevant to indirect costs might include any or all of the following:

- Time frame of the analysis,
- Magnitude of the change in force structure,
- Category of indirect cost element (five in our tools), and
- Type of unit or manpower driving the change.

A relevant issue here is the time frame of the analysis—the duration over which the modeling results will be applied. Consider for example how cost savings will differ in the short-term and long-term due to force-structure increases. For a short time frame, only direct costs are likely to change: personnel costs, equipment operating costs, and limited procurement costs. It is not likely indirect costs would change to the same magnitude, if at all. As the timeframe of the analysis increases, direct costs would continue to be affected; however, an increasing portion of indirect costs would likely be affected as infrastructure adapts to the new force structure. Taken to the extreme, long-term increases in force structure may generate marginal changes in indirect costs approaching 100 percent variable. In this case, the user may choose to select all indirect costs as 100 percent variable.

8. Including Other Costs

Other costs include special training events, modernizations, transition hurdles, prepositioning stocks, and other similar undertakings. These costs cannot be easily integrated into a simple tool, and are not reliably estimated using averages. They may, however, be worth including if they are well known or the user would like to experiment with alternative unit costs. Thus, this function can be used as a "catch all" in order to capture additional, alternative, or unique costs. It is up to the user to identify and input these events. As shown in Figure 26 these costs can be a function of almost any cost driver, e.g., the number of personnel, the unit type, or the duration of the phase cycle.

Description	Scenario	Unit	Personnel	Phase	Metric	Value
Event 1	Default	Strategic	N/A	N/A	$/Unit	0
Event 2	Default	Strategic	N/A	N/A	$/Unit	0
Event 3	Default	Strategic	N/A	N/A	$/Unit	0
Event 4	Default	Strategic	N/A	N/A	$/Unit	0
Event 5	Default	Strategic	N/A	N/A	$/Unit	0
Event 6	Default	Strategic	N/A	N/A	$/Unit	0
Event 7	Default	Strategic	N/A	N/A	$/Unit	0
Event 8	Default	Strategic	N/A	N/A	$/Unit	0
Event 9	Default	Strategic	N/A	N/A	$/Unit	0
Event 10	Default	Strategic	N/A	N/A	$/Unit	0

Figure 26. Other Costs

Accounting for these possibilities in a tool makes it simple to add extra costs. A modeler should consider factors such as the type of unit, the CONOPS, the cost-driving metric, and cost factor source when adding other costs. Allowing alternative possibilities to be considered when modeling unit costs provides important flexibility. For example, a unit that must report to a training center before it deploys may require an additional per person cost during its final dwell phase. The **Other Costs** functionality could be used to handle such a unit-specific requirement.

D. Standard Outputs

1. Introduction

This section discusses tool outputs. The figures and tables are based on a specific set of inputs and assumptions chosen for this particular analysis. We have selected a typical Marine Corps Light Armored Reconnaissance Battalion (LAR BN) for the illustrative analysis shown in Table 6. The "Range of Alternatives" considers alternative community sizes according to a percentage increase and decrease. The initial force structure includes the set of characteristics and assumptions shown in Table 6. Force-structure size is not intended to reflect actual force design and is purely notional.

Table 6. Notional Marine Corps Community

LAR BN	Active Component		Reserve Component		Total
	Quantity	Range of Alternatives	Quantity	Range of Alternatives	
Strategic	0	+/-0%	0	+/-0%	0
Available	4	+/-25%	4	+/-25%	8
Rotating	4	+/-25%	4	+/-25%	8
Deployed	0	+/-0%	0	+/-0%	0
Total	**8**	**+/- 25**	**8**	**+/- 25%**	**16**

Note: Assumes 1,021 Marines and 80 Sailors per Battalion.

Key inputs to the tool include Active and Reserve Component phases, BOG-to-dwell ratios, MOB-to-dwell ratios, resourcing levels, and activity levels. These appear in the tool as shown in Figure 23 and Figure 27. Settings for this analysis include:

- Active BOG-to-dwell of 1:3 and Reserve MOB-to-dwell of 1:5
- Deployed activity rate of 3.0 for the AC and 3.5 for the Reserve (Reserve higher when deployed due to lower non-deployed activity rate)
- Increased indirect costs during mobilization and deployment of 10 percent (additional costs associated with deployed installations)
- Equipment replacement over 30 years at the authorized level
- Equipment modification costs of 1 percent of asset value per year
- Fuel price of $4.50 per gallon in the modeled base year
- Reserve units including 10 percent Active-Reserve
- Included ammunition procurement linearly variable with the activity rate
- Indirect costs variable at 50 percent with the number of personnel

Reserve Units		Months	Active Personnel			Reserve Personnel			Activity		Equipment		Indirect	
Strategic		72	-30%		68	-30%		604	0.9		-20%		-10%	
Dwell 1		12	-15%		81	-15%		735	0.8		-10%		0%	
Dwell 2		12	-15%		81	-15%		735	0.9		-5%		0%	
Dwell 3		12	-10%		86	-10%		778	1.0		0%		0%	
Dwell 4		12	-10%		86	-10%		778	1.0		0%		0%	
Dwell 5		12	0%		96	0%		864	1.5		0%		0%	
Dwell		60	-10%			-10%			1.0		-3%		0%	
Mob 1	Mob	4	0%		96	0%		864	2.5		0%		+10%	
Mob 2	Bog	7	0%		96	0%		864	3.5		0%		+10%	
Mob 3	Mob	1	0%		96	0%		864	2.5		0%		+10%	
Mob	1:5.0	12	0%			0%			3.1		0%		+10%	
Bog	1:9.3	7	0%			0%			3.5		0%		+10%	
Rotating		72	-8%			-8%			1.4		-3%		+2%	
Available	Dwell 3	72	-10%	-10%	86	-10%	-10%	778	1.0	1.0	-3%	0%	0%	0%
Deployed	24 Bog	72	0%		96	0%		864	3.5		0%		+10%	
		0	0%			0%			1.0		0%		0%	

Figure 27. Reserve Component Resourcing and Activity Levels

2. Force Structure Cost and Rotational Capability

For a given user-designed force-structure alternative, combining the AC-RC force mix with the selected inputs produces an estimate of two factors: cost and operational capability. This estimate appears in Table 7. Cost is reported in millions of dollars per year with both cost and capability appearing by unit category and in total. The selected force structure of 16 battalions costs in total $2.27 billion in FY 2013 dollars annually.

Table 7. Notional Marine Corps Community Cost and Capability

LAR BN	Active Component				Reserve Component			
	Qty	Cost	Max BOG	BOG	Qty	Cost	Max BOG	BOG
Strategic	0	0	0.00	0.00	0	0	0.00	0.00
Available	4	700	1.00	0.00	4	219	0.67	0.00
Rotating	4	929	1.00	1.00	4	422	0.67	0.39
Deployed	0	0	0.00	0.00	0	0	0.00	0.00
Total	**8**	**1,629**	**2.00**	**1.00**	**8**	**641**	**1.33**	**0.39**

The "Max BOG" is the potential operational BOG, on an annual basis, generated for all AC and RC units for a given AC-RC rotation policy. "BOG" is the portion of the "Max BOG" generated by units that are actually deployed, given the assumptions made about the portion of rotational units that deploy when they become available. Table 7 shows the specified 16-unit force structure generating a total of 3.33 years of "Max BOG" on an annual basis. The eight "rotating" units generate 1.39 units of actual deployed BOG. Thus, the 16-unit force mix as structured costs $2.27 billion, has a maximum operational capacity of 3.33 deployed units, and is expected to provide 1.39 operational deployed units.

3. A Graphical Display of the Range of Units and Community Alternatives

This section presents sample graphs for the force-structure alternatives. Figure 28 displays 16 units with the complete range of possible AC-RC force-mix alternatives. We present the output in the same manner as the figures in the Introduction chapter and depict the force-mix alternative introduced previously (8 AC and 8 RC units) as a single (blue) point. The figure additionally presents a sensitivity analysis varying the AC-RC mix and the rate at which available units are called upon to deploy. This sensitivity analysis deviates from the blue point to form a region that contains all possible AC-RC force-mix alternatives given the strategic requirement (in this case, 16 units).

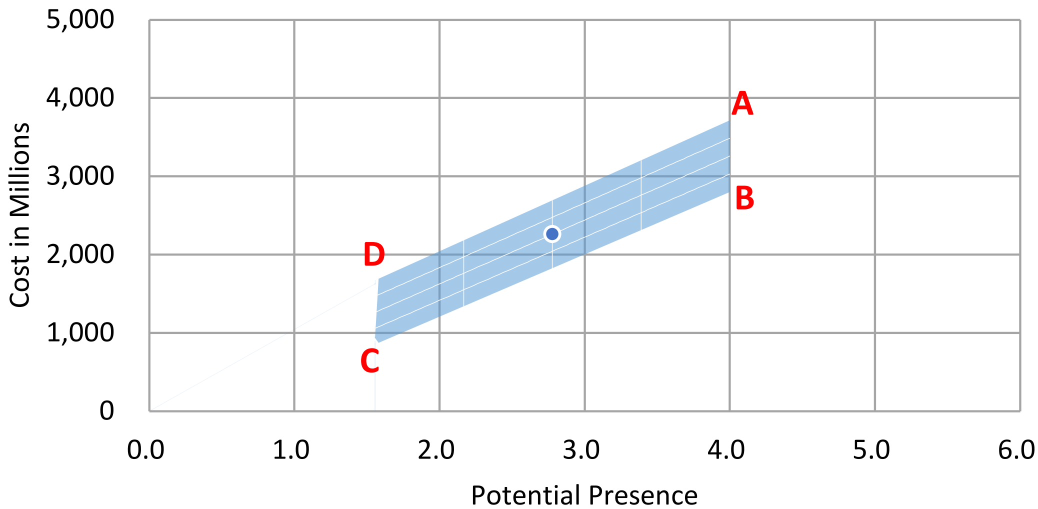

Figure 28. Point Estimate and Rotational Unit Alternatives

Regional boundaries beginning at point A and, moving clockwise, represent the following individual force-structure capabilities:

- Top, right (A): rotational AC units, trained and deployed when available
- Bottom, right (B): rotational AC units, trained and never deployed
- Bottom, left (C): rotational RC units, trained and never deployed
- Top, left (D): rotational RC units, trained and deployed when available

Joining these discrete points forms the region in Figure 28. Changing the force mix and CONOPS by adding or subtracting strategic or deployed units would shift the region, but would not alter its basic shape. No such units are considered here.

As expected, increasing the percentage of AC increases costs and operational presence. The range of all possible AC-RC force-mix alternatives within the selected 16-unit force structure produces potential operational output of between approximately 1.6 and 4.0 units per year at a cost of between $970 million and $3,700 million per year. In years with no deployment requirement, costs might decrease more than 40 percent relative to years where deployment is high, most for RC-heavy force structures. The extremes are represented by Points A and C: A is a 100 percent AC force mix that produces 4.0 units of BOG for a minimum cost of $2,820 million; C is a 100 percent RC force mix that produces 1.6 units "available" at a cost of $970 million per year.

Figure 29 expands on Figure 28 to include a more sophisticated comparison of multiple force structures of 12, 16, and 20 units that add and remove four rotational units of each Component.

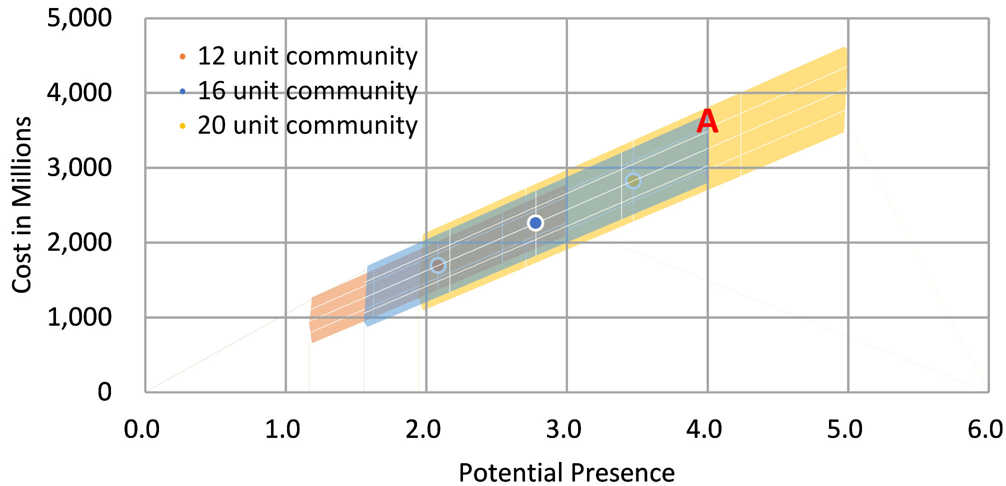

Figure 29. Point Estimate with Current and Alternative Force Structures

In the case shown in Figure 29, larger force structures (moving from 12, 16, to 20 units) with higher percentages of RC units can provide a constant level of operational availability with increased strategic capability for the same as or lower cost than in cases where deployment demand is relatively low. As deployment demand increases, RC-heavy force structures become slightly more expensive as measured using operational presence. Thus, the RC-heavy force structures provide greater opportunity for cost savings than the AC-heavy forces as deployments decrease while maintaining larger strategic depth. The steep negative slope of all regions implies substantial savings when trading AC for RC units.

As an example, we consider point A in Figure 29, which identifies two alternative force structures: a 16-unit, 100 percent AC force that utilizes 100 percent of available units and a 20-unit, 70 percent AC force that utilizes 90 percent of available units. Both force mixes deploy approximately 4.0 units per year at an annual cost of $3,700 million, but the RC-intensive structure includes an additional 4.0 units of strategic capacity.

Figure 30 presents the same three communities of 12, 16 and 20 units. However, in this case the slope of the regions is slightly steeper. This is because both the AC, at a BOG-to-dwell ratio of 1:3, and the RC, at a MOB-to-dwell ratio of 1:3, employ the same rotational pattern (probably unrealistic unless an escalation of conflict drives a policy change). In this case, RC-heavy force structures offer greater advantages and more significant cost savings on a unit-for-unit basis as measured using changes in presence. The reason is that under these assumptions an RC unit generates greater potential presence relative to an AC unit while maintaining still lower, but elevated, dwell costs (higher readiness is funded during dwell to allow for greater availability). As expected in most cases, increasing RC availability improves its ability to replace AC units, even given the necessary increase in RC dwell resourcing and activity.

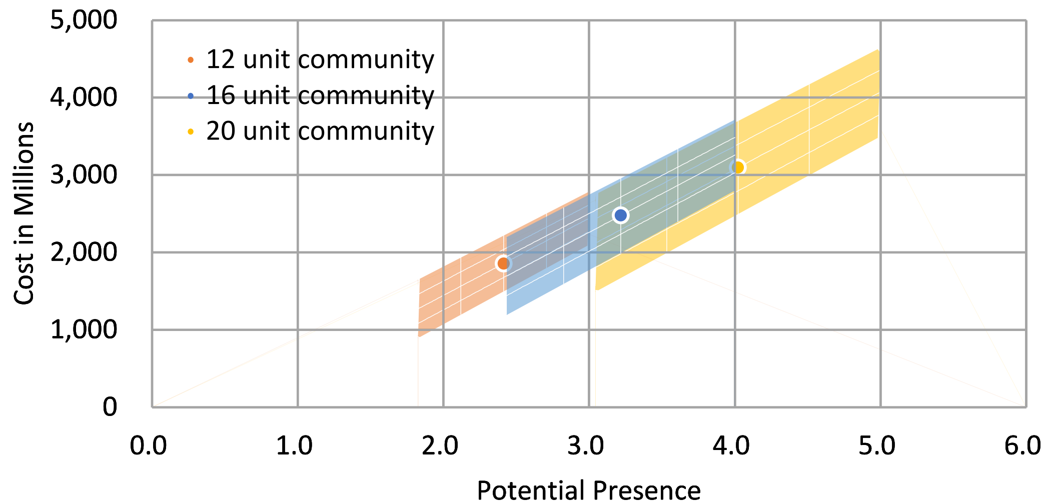

Figure 30. Alternative Rotational Pattern Excursion

4. Air Force Modeling

A. Introduction

This chapter describes the Air Force methodology and supporting tool. It begins with a description of data sources in Table 8, which are illustrated in greater detail throughout the remainder of the chapter. This is followed by sections on the primary components of the methodology and the associated elements of the tool—selection of the aviation community being analyzed; determination of force size and mix; definition of employment policies; setting of training, resourcing, and manning levels; and treatment of indirect cost factors. The chapter concludes with a discussion of the outputs.

The Air Force is modeled using its specific aircraft-type flying communities at the mission design series (MDS) level. Each community is analyzed separately as the cost factors change for different types of aircraft. An aircraft-type community can be composed of Active, Reserve, and National Guard aircraft for the given MDS. This tool is primarily designed to provide a community cost, but it also calculates the collective operational output in terms of hours or sortie generation.

Operational output is provided along two dimensions: flying hour or sortie capacity and operational flying hours or sorties. The difference between hours and sorties is simply the average sortie duration, with flying hours and sorties used interchangeably to describe output. Capacity describes the number of hours or sorties that a particular community can produce under surge conditions. Operational output refers to the number of hours or sorties the community can produce during steady state to meet both non-deployed and deployed operational demand, which depends on a series of assumptions.

The user specifies the force structure, resourcing, and expected activity levels of the aviation system community. These inputs change the number of aircraft and crews as well as the activity level of those crews, which in turn changes the flying activity and thus the operational output and cost. Costs not directly associated with flying are scaled to aircraft and activity. Section 4.C describes these inputs in more detail, and how each affects the notional force, activity, and cost. Section 4.D then describes the outputs.

B. Data Sources

Table 8 lists data sources. How the data is employed is described in detail in Section 4.C. OSD publishes the personnel data cost factors used in the tool. The Office of the Assistant Secretary of the Air Force (ASAF), Financial Management and Comptroller (FM&C) publishes Air Force Instruction (AFI) 65-503, which contains official cost factor tables for the Air Force, as well as notional structures for flying squadrons. AFI 11-2 contains flying hour requirements and restrictions. The Air Force Equipment Management System (AFEMS) is a database that contains all equipment valued at over $5,000, separated by unit and unit type. The FYDP is a Department-wide database with costs for major programs. The IDA COST contains deployment costs.

Table 8. Primary Air Force Data Sources

Category	Source
Personnel	OSD
Equipment Operations and Maintenance	AFI 65-503 AFI 11-2
Equipment Replacement	AFEMS
Indirect	AFI 65-503 FYDP
Deployment	IDA COST AFI 65-503 Air Force Total Ownership Cost (AFTOC)

C. Using the Model

Users must specify inputs to define the various force-structure alternatives to be analyzed. The intent is to develop a set of force-structure and force-mix alternatives in an effort to seek the most acceptable force mix in terms of cost, operational capability, and strategic capacity. The tool is constructed initially using Microsoft Excel and includes the following elements:

- Model inputs—items that the user can change—appear as blue text
- Locally calculated values—most using model algorithms—appear as black text
- Linked calculated values appear as green text
- Important intermediate output—derived operational factors—appears as red text
- Primary output—cost and capability—appears as gray-on-gray text
- Explanatory text appears in gray

1. Selecting Aviation System Type

Figure 31 displays the system selection portion of the Air Force tool.

System Selection		
System	All	F-16C/D
Active CMD		ACC
Reserve CMD		AFR UE
Guard CMD		ANG

Sqn Metrics	AC		RC		NG	
Systems	24	0	24	0	21	0
Crew Ratio	1.25	0.00	1.25	0.00	1.25	0.00
System Hours	312	0	233	0	180	0

Figure 31. System Selection Portion of the Air Force Tool

In designing the analysis, users select the flying community by selecting an aircraft type at the MDS level (in the case of Figure 31, the F-16C/D is selected). Selections must be made in four categories. First, the user selects the aircraft type (**System** field). The **System** field drop-down list provides a list of the currently available aircraft system types. Second, the user selects the Component Command. For example, Air Combat Command (ACC) may be selected for the **Active CMD**, Air Force Reserve Command (AFRC) may be selected for the **Reserve CMD**, and Air National Guard (ANG) may be selected for the **Guard CMD**. In the case of the F-16 aircraft type, all three Components have F-16C/Ds and therefore should all be selected unless the analysis is going to consider an alternative that eliminates the F-16 from one of the Components. In terms of the graphical outputs, and for the purposes of display, only the Active CMD and a single Reserve CMD can be selected for display.

2. Selecting the Force Size and Mix Alternatives

Once the user selects the MDS, they must specify the force structure in terms of how many aircraft are in the Active, Reserve, and National Guard Components. By doing this, the user is selecting the component force mix for this alternative. The status quo force mix can be selected as well as alternative force mixes. Figure 32 displays the force-structure selection portion of the Air Force tool.

Number of Systems	AC	+/-	RC	+/-	NG	+/-
Strategic	1	0%	1	0%	1	0%
Available	1	0%	1	0%	1	0%
Rotating	1	0%	1	0%	1	0%
Deployed	1	0%	1	0%	1	0%
Unit Total	4		4		4	

Figure 32. Force Structure Portion of Air Force Tool

An aviation community comprises the total number of aircraft systems in each Component. Each community includes the selected number of aviation systems as well as the associated quantity of personnel, support systems, and equipment. In many cases, complete aircraft units do not deploy together as in other Services, such as the Army; thus it is preferred to gather and analyze costs by "system" rather than unit. However, similar to the standard for other Services, when designing a force-mix alternative for aircraft systems, four categories of operational use are available. These choices include the number of non-rotational systems (strategic and deployed), and the number of rotational systems (available and rotating).

Strategic systems[6] are intended to be most similar to systems with crews that fly at the Basic Mission Capable (BMC) rate, described in more detail in Section 4.C.5, “Setting Resource and Activity Levels.” They are not ready for full spectrum or demanding operations, but can be made ready with spin-up time. Systems and crews assigned to this category may be ready for certain non-demanding operations in the event of a major contingency. Any Component can include strategic systems and crews.

Users can reduce training for strategic systems to below the BMC rate by adjusting the training activity level, as described in follow-on sections. However, users should be cautious when doing so, as any flying rates below BMC may make flying unsafe, and may be a low-probability assumption. Users will also likely want to provide the strategic force with relatively low operational resource and operational activity levels in Section 4.C.5, “Setting Resource and Activity Levels.”

Deployed systems are intended to describe those systems and crews permanently located outside of CONUS in a high tempo or operational environment. This system category may be alternatively described as including forward “fenced” aviation systems, meaning systems committed to a specific mission that do not offer rotational availability. Any Active, Reserve, or National Guard system may be categorized as forward deployed. RC forward deployed systems could conceivably be maintained through a system of voluntary individual replacements; however, they are assumed to be unlikely. Users will likely want to provide deployed systems with relatively high resource and activity levels in Section 4.C.5, “Setting Resource and Activity Levels.” In some respects, the deployed systems represent the maximum, typical annual cost for the type of system selected.

Rotational systems include both “available” systems and “rotating” systems. The number of rotational systems determines the number of systems and crews that are available to rotate in and out of a theater of operation, and make up the bulk of the current operational Air Force. Crews for rotational systems rotate with their equipment between deployed and dwell status according to a rotation rate set by the user.

The total number of rotational systems, and rotation rules, determine the maximum number of forces available for deployment at any given time, but they do not determine how many actually deploy. Depending on the user’s assumptions regarding the percentage of systems that will deploy during their available period, the user will set the number of available aviation systems (aircraft that do not deploy) and rotating aviation systems (aircraft that do deploy). The percentage that deploy depends on expectations of

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6 Note that “strategic” does not here refer to strategic missions, such as nuclear missions. Rather it refers to not being deployed except in surge conditions.

the future operational environment and associated steady state, non-surge requirements. Zero systems set to “Available” means that all systems and crews deploy during their period of availability. All systems set to “Available” means there will be no deployments. The percent of rotational systems deploying contributes to the ratio of non-deployed and deployed hours or sorties. It also affects costs, because deployment imposes additional costs above those in the available phase.

3. Defining Training Assumptions

In this section, the user can specify assumptions about training requirements.

The user currently inputs the Training Requirement in terms of flight hours per crew per month. These are the number of flight hours that crews must fly every month in order to remain trained for full spectrum operations. Note that these hours are not the number of flight hours that are coded as training hours, but the minimum number of hours that must be flown to maintain aviation currency. A good baseline is the minimum volume requirement for units according to their MDS-specific AFI 11-2v1s and the Major Command (MAJCOM) and MDS-specific Ready Aircrew Program (RAP) Training Manuals (RTMs).[7]

“**Percent Replaceable Training Sorties**” is an important concept associated with the number of training hours. The user can select the percent of RAP currency and volume training requirements that can be replaced with operational hours. This percentage only applies to units in dwell status and is an important component of the measurement of non-deployed operational hours or sorties. Deployed systems can replace 100 percent of their training hours with operational hours.

AFI 11-2v3 limits the number of flight hours that crew members are allowed to fly per period,[8] so replacing training with operational hours increases the number of

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7 Training volume requirements and currency requirements interact to create slightly different requirements for different time periods, while allowing some flexibility in training timing. Crew members for different MDSs have a sortie volume goal per month, but must meet a three-month look back to maintain their rating. This means that if the volume requirement is eight sorties per month, a pilot can get away with fewer sorties one month if they make them up the following month, as long as at the end of each month they have completed 24 sorties in the past three months. Currency requirements specify the maximum amount of time that a crew member can go between completing certain tasks, such as landing at night. This prevents a crew member from completing their entire three-month volume requirement at once. Because the interaction between these requirements changes the hardline requirement for monthly and three-month periods, we refer to requirements per period rather than specifying per month. In the tool, we further avoid the currency requirement complication by using the RTM one month goals, assuming that at the community level, sorties will average to this number.

8 The limit differs slightly by period. There are daily, monthly, and three-month maximums, to allow short term flexibility while preventing unsafe pilot stress. Because the analysis is at the aggregate community level, we use the most limiting requirement: the three-month requirement. This is because on average, monthly or daily flying cannot exceed this limit.

operational hours or sorties a pilot can generate. That noted, replacing training hours with operational hours might decrease the full-spectrum readiness of the unit, because operational missions do not train crews for more demanding or diverse operations. The percent replaceable should vary by MDS or aircraft type. Certain aircraft categories, such as heavy lift, generally can receive most training through operational hours, and thus could have up to 100 percent replaceable hours. Fighters, on the other hand, require full-spectrum training, and therefore usually should not have their dwell training hours replaced by operational flight hours. Some combat aircraft do provide non-deployed operational output in missions such as homeland defense.

4. Setting Dwell and Deployment Phase Structure for Rotational Units

The tool allows the user to specify phases of varying duration in which systems can have different levels of resourcing and operational output. The phases during which systems are not mobilized or deployed are termed “dwell.” Users can specify up to five separate dwell phases, entering the number of months in each phase. Similar to the Army and Marine Corps, the dwell phases can be designed to accommodate various types of CONOPS for a community. The phases during which systems are mobilized or deployed are called “MOB”—one for mobilization, one for deployment, and another for demobilization. The mobilization and demobilization periods may be used to model transit time or overlap time, as well as post-deployment downtime.

In current practice all rotational units are divided into Air and Space Expeditionary Force (AEF) rotation groups. These units cycle through two major phase elements: dwell and available (often called “vulnerable”). Dwell is further divided into two major phases, normal operations and “spin-up.” During normal operations, all crews are fully ready. They produce non-deployed operational sorties and complete their primary training requirements. During spin-up, crews prepare for their future mission or full-spectrum operations, and dedicate more of their time to training. During their available phase, crews are ready to be assigned to deploying task forces without advance notice. Deployment is followed by two weeks or more of post-deployment downtime, during which they generally do not fly.

Figure 33 shows the tool’s entry screen with an example of how this kind of pattern can be depicted for an Active system. The rotation rules are specified separately for the Active, National Guard, and Reserve aircraft systems, but the entry process is identical. For Active aircraft systems, normal training and non-deployed operations may last for 14 months (dwell 1), spin-up, two months (dwell 2), and crew vulnerability (deployment availability), for four months. For high-demand systems, the cycle can be compressed; for low-demand systems, the cycle can be expanded.

Active Systems			**Months**
Strategic			21
Dwell 1			14
Dwell 2			2
Dwell 3			0
Dwell 4			0
Dwell 5			0
Dwell			16
Mob 1		Mob	0
Mob 2		Bog	4
Mob 3		Mob	1
Mob		1:3.2	5
Bog		1:4.3	4
Available			21
Rotational		Dwell 2	21
Deployed	24	Bog	21
			0

Figure 33. Specification of Phase Structure for Projected Rotational Units

Not all aircraft systems that are available to deploy, will deploy. These systems were introduced earlier as "available" systems. An additional phase setting is necessary to cover the resourcing of systems that do not deploy during the available period. Using a drop-down menu, users may select a representative dwell phase that systems will occupy if they fail to deploy. The resource settings for this phase will only apply to non-deployed units that remain available. This capability may be used to maintain available RC units as activated or AC units in a high state of readiness.

No phase structure is required for strategic or deployed aviation systems, since their resource and readiness levels are assumed to be constant. Deployed, or fenced, systems can be designed as systems permanently assigned to an active operational environment or stationed in a high tempo forward location. As a standard, a strategic system may be assumed to operate at the minimum level of resourcing and a deployed system at the maximum level of resourcing.

5. Setting Resource and Activity Levels

Figure 34 shows the structure for specifying the resource and activity levels for strategic, rotational—both available and rotating—and deployed aviation systems in each phase of the rotational cycle. Active, Reserve, and National Guard aircraft systems must each be addressed separately. User input may be provided for four categories of resource and activity level: personnel (Active Personnel and Reserve Personnel), training and operational activity measured by an OPTEMPO multiplier (Activity), equipment fill-rate (Equipment), and indirect costs (Indirect). Resource levels can be specified for both AC and RC personnel associated with all aviation systems.

Active Systems		Months	Active Personnel			Reserve Personnel			Activity		Hours	Op Hrs	Equipment		Indirect	
Strategic		21	0%		32	0%		0	1.0		23.6	8.4	0%		0%	
Dwell 1		14	0%		32	0%		0	1.0		23.6	8.4	0%		0%	
Dwell 2		2	0%		32	0%		0	2.0		47.1	31.9	0%		0%	
Dwell 3		0	0%		32	0%		0	0.0		0.0	0.0	0%		0%	
Dwell 4		0	0%		32	0%		0	0.0		0.0	0.0	0%		0%	
Dwell 5		0	0%		32	0%		0	0.0		0.0	0.0	0%		0%	
Dwell		16	0%			0%			1.1		26.5	11.3	0%		0%	
Mob 1	Mob	0	0%		32	0%		0	2.0		47.1	31.9	0%		0%	
Mob 2	Bog	4	0%		32	0%		0	5.3		110.0	94.8	0%		0%	
Mob 3	Mob	1	0%		32	0%		0	1.0		23.6	8.4	0%		0%	
Mob	1:3.2	5	0%			0%			4.4		4.7	1.7	0%		0%	
Bog	1:4.3	4	0%			0%			5.3		88.0	75.8	0%		0%	
Rotational		21	0%			0%			1.9		92.7	77.5	0%		0%	
Available	Dwell 2	21	0%	0%	32	0%	0%	0	1.3	2.0	47.1	31.9	0%	0%	0%	0%
Deployed	24 Bog	21	0%		32	0%		0	3.0		70.7	55.5	0%		0%	
		0	0%			0%			1.0				0%		0%	

Figure 34. Setting Resource and Activity Levels

Personnel resourcing levels affect the number of crews and other personnel assigned to a system. The default setting for Active and Reserve personnel levels—the default number of crews assigned to the system according to the crew ratio, plus all associated supporting personnel (e.g., maintenance, munitions, and security)—is 0 percent. Entering a new percentage will linearly scale up or down the number of FTEs. If resourcing increases, the crew ratio will increase proportionately. Personnel resourcing adjustments should be used primarily to modify the number of personnel available to the unit during a specific phase.

Personnel resourcing can be shifted to represent instances when a system has more or fewer personnel than authorized. For example, after a task force returns from deployment, Service members may leave for a variety of reasons—their enlistment has ended, they may be reservists attached to Active squadrons, or they may go back to school. For periods prior to deployment, such as during spin-up, units may be over-manned to account for possible attrition or additional training and logistics staff. Therefore, it is reasonable to allow systems to have more than the authorized number of personnel during some periods.

Equipment resourcing adjusts the amount of equipment (other than the aircraft itself) associated with a system. Equipment is taken from the AFEMS database as well as from publicly available sources on equipment unit cost. AFEMS contains the equipment owned by actual units; however, the tool scales this data by the number of primary aircraft assigned (PAA) by Component. This assumption may not be changed, although it is likely unsuitable for small aviation communities.

The default equipment input level is 0 percent, which indicates that the unit has the average amount of equipment per system. A negative equipment resourcing percentage decreases the amount of equipment assigned. During dwell periods, total equipping of less than 100 percent is possible and likely. For deployments, an assumption of 100 percent equipped is reasonable. Changing the amount of equipment on hand adjusts the amount of equipment used to support training, which may affect associated operating costs as well as procurement costs.

Operational activity drives the number of sorties that are generated by a system by defining the number of hours flown per crew. The sortie *capacity* is the maximum number of sorties the systems can generate according to physical limitations and safety constraints as described in AFI 11-2 volume 3. In non-surge conditions, the force is unlikely to fly at capacity. The activity level is set for each Component, and represents the fraction of the flying hour or sortie capacity the user expects the forces in that Component to fly. A value of 1 indicates that the crews assigned to an aircraft can fly the average number of historical dwell hours. Values between 1 and 0 indicate that systems fly fewer than average hours; values above 1 indicate that systems fly more hours.

Figure 35 displays inputs on training, operational activity, sortie lengths, and constraints on the number of hours crews can fly that interact with the operational activity factor to determine costs and outputs. For example, consider an A-10 pilot flying at the Combat Mission Ready (CMR) rate. The training requirement for such a pilot is 16 hours per month. Pilots are limited to a maximum of 110 hours per month. Imagine that in dwell, 20 percent of the training hours can be replaced by operational hours. The average number of hours flown per system is 30 and there is a crew ratio of 1.25, which means that the average pilot flies 24 hours per month. An OPTEMPO input of 1 would imply that pilots can fly those 24 hours per month. Sixteen of those hours will be for training, but 3.2 of the 16 can be operational. The eight hours beyond the training requirement can also be operational, for a total of 11.2 non-deployed operational hours. The maximum number of operational hours is 95.2, but that would require a much higher activity level. Both total and operational hours are displayed.

	AC	RC	NG
Required Crew Training Hours	16	16	16
% Replaceable Training Hours	+20%	+20%	+20%
Sortie Length Hours (Operational)	1.5	1.5	1.5
Sortie Length Hours (Rotational)	2.0	2.0	2.0
Crew Maximum Hours	110	110	110

Figure 35. System Hours and Sortie Settings

Operational activity can be adjusted to reflect different circumstances or different AEF phases. For example, it might be decreased during the available period while systems are still in CONUS because crews are on-call for contingency operations, and thus may not be flying as many non-deployed operations. OPTEMPO should be lower for the Air Reserve Component (ARC), which is limited by its part-time nature. Note that resourcing can be reduced below the level needed to fly the "required" training hours. An OPTEMPO level of 0 signifies a system that is not flying.

Operational activity drives pay for reservists not in mobilized status as well as operating costs and equipment replacement costs for all systems. If flying during dwell increases for ARC systems, the number of days of activity is assumed to increase proportionately. Operating costs during the specified phase or for deployed or strategic units are modified according to the factor entered. Operating costs depend on both the amount of equipment on hand and the activity level applied to that equipment.

The default level of 0 percent for indirect indicates full funding of relevant indirect costs, and indicates as well that the system generates a typical amount of indirect cost during that phase. Changing the amount of indirect resources affects indirect operating costs. It may be appropriate to adjust this funding upward for austere or forward training and operating environments not typical of a normal rotational or strategic location.

6. Choosing Equipment Assumptions

Equipment and ammunition replacement costs are affected by Procurement Strategy, Equipment Life in Years, Ammunition Replacement, Annual Depot Rate, and the Equipment Modification Rate. These inputs are specified in "Equipment and Personnel," for Active, Reserve, and National Guard systems, to the right of "Resource and Activity Levels." Figure 36 displays the structure for specifying equipment replacement cost inputs.

Equipment and Personnel	
Procurement Strategy	Auth
Equipment Life in Years	30
Include Ammunition	Yes
Annual Depot Rate	0%
Equipment Modification Rate	1%
Miltech Personnel	0%

Figure 36. Setting Equipment Replacement, Ammunition, Depot, and Modification Inputs

Procurement Strategy is selected from a drop-down menu containing the choices "Auth" (Authorized), "Avail" (Available), or "None." "Auth" indicates replacement at an authorized level of equipment rate, "Avail" means replacement at an on-hand equipment rate, and "None" excludes equipment replacement. This will affect the equipment replacement costs by changing how frequently equipment is replaced.

Equipment Life in Years is the time in years over which equipment will be replaced, on average. The tool assumes a 1.0 activity level represents one year of equipment replacement as the default for the selected procurement strategy. The entry in the **Equipment Life in Years** input affects the rate at which equipment is replaced, and therefore the equipment replacement costs.

The user may choose whether or not to include ammunition in procurement costs in the third input field under **Equipment and Personnel (Include Ammunition)**. Ammunition costs are a function of equipment resourcing and the activity level. Including ammunition will change the total annual procurement costs. The user may then specify an **Annual Depot Rate**. This is the percentage of the unit's procurement cost used to represent additional depot costs, on an annual basis, for the system. This is set to 0 by default.

The **Equipment Modification Rate** is the final input field related to equipment operating and replacement costs. It indicates the percentage of the total acquisition cost of the unit necessary to fund typical O&M-funded modifications. It funds both hardware and software modifications. This is typically between 0 percent and 10 percent on an annual basis and is included in O&M costs.

7. Modeling Indirect Costs

Indirect cost factors—such as Installation Support, Personnel Administration, Personnel Benefits, Medical Care, and General Training and Education—can be specified by the user. The factors reflect those marginal costs that are not directly generated by the aviation system, but are allocated to the aviation system. Figure 37 displays the area where **Indirect Factors** are set.

Indirect Factors	
Installation Support	50%
Personnel Administration	50%
Personnel Benefits	50%
Medical Care	50%
General Training and Education	50%

Figure 37. Indirect Costs

Indirect costs are based on cost data from AFI 65-503 as well as from three years (2009–2011) of historical spending from the FYDP. FYDP-based factors were used as a rough check and to fill in gaps in the information available from AFI 65-503; e.g., medical costs. They are calculated as the cost per person for the AC or as the cost per effective FTE for the RC. The inputs shown in Figure 37 set the percentage of the total indirect costs that will be treated as marginal with changes in the force structure. The default assumption within the tool is that indirect costs are half (50 percent) fixed and 50 percent variable with changes in the number of people (and systems). For example, a 10 percent reduction in AC equipment will, according to the accounting rules described herein, reduce "Installation Support" by 5 percent for the AC.

The factors involved in determining the marginal cost may change depending on the timeframe of interest to the user. For a shorter timeframe, direct costs such as personnel and equipment may be very relevant to changes in the force structure, but indirect costs may not. Alternatively, as the timeframe of the analysis increases in duration, indirect costs may become more important. Over the long term, it might be assumed that all indirect costs are variable with changes in the force structure.

8. Including Other Costs

Other costs include special training events, modernizations, transition hurdles, prepositioning stocks, and other similar undertakings. These costs cannot be easily integrated into a simple tool, and are not reliably estimated using averages. They may, however, be worth including if they are well known or the user would like to experiment with alternative unit costs. Thus, this function can be used as a "catch all" in order to capture additional, alternative or unique costs. It is up to the user to identify and input these events. As shown in Figure 38, these costs can be a function of almost any cost driver; e.g., the number of personnel, the unit type, or the duration of the phase cycle.

Description	Scenario	Unit	Personnel	Phase	Metric	Value
Event 1	Default	Strategic	N/A	N/A	$/Unit	0
Event 2	Default	Strategic	N/A	N/A	$/Unit	0
Event 3	Default	Strategic	N/A	N/A	$/Unit	0
Event 4	Default	Strategic	N/A	N/A	$/Unit	0
Event 5	Default	Strategic	N/A	N/A	$/Unit	0
Event 6	Default	Strategic	N/A	N/A	$/Unit	0
Event 7	Default	Strategic	N/A	N/A	$/Unit	0
Event 8	Default	Strategic	N/A	N/A	$/Unit	0
Event 9	Default	Strategic	N/A	N/A	$/Unit	0
Event 10	Default	Strategic	N/A	N/A	$/Unit	0

Figure 38. Other Costs

Accounting for these possibilities in a tool makes it simple to add extra costs. A modeler should consider factors such as the type of unit, the CONOPS, the cost-driving metric, and cost factor source, when adding other costs. Allowing alternative possibilities to be considered when modeling unit costs provides important flexibility. For example, a unit that must report to a training center before it deploys may require an additional per person cost during its final dwell phase. The **Other Costs** functionality could be used to handle such a unit-specific requirement.

D. Standard Outputs

1. Introduction

This section discusses the primary tool outputs. The figures and tables are based on a specific set of inputs and assumptions chosen for this particular analysis. We have selected the A-10C as the system for this notional analysis. In this case, we assume the force structure includes AC and RC units. The initial force mix includes the set of characteristics and assumptions shown in Table 9. The force structure is intended to be notional and for example purposes only. Although the model produces displays for both non-deployed and deployed output, only deployed output is displayed in this section.

Table 9. Notional Air Force Community

A-10C	Active Component		Reserve Component		Total
	Quantity	Range of Alternatives	Quantity	Range of Alternatives	
Strategic	30	+/-0%	30	+/-0%	60
Available	45	+/-25%	45	+/-25%	90
Rotating	45	+/-25%	45	+/-25%	90
Deployed	0	+/-0%	0	+/-0%	0
Total	**120**		**120**		**240**

Note: Assumes an average of 24 aircraft per AC and RC Squadron.

Key inputs to the tool include Active and Reserve phases, BOG-to-dwell ratios, MOB-to-dwell ratios, resourcing levels, and activity levels. These appear in the tool as shown in Figure 34 and Figure 39.

The AC employs a BOG-to-dwell ratio of 1:4.3 and the RC employs a MOB-to-dwell ratio of 1:5.3. The RC BOG-to-dwell ratio in our example is set to 1:11.5. Deployed activity is set to 530 percent of normal non-deployed activity for Active aircraft and 850 percent of normal peacetime activity for Reserve aircraft. This provides for equal, maximum effort, as measured by the number of monthly flying hours during the deployment phase for both components.

Reserve Systems		Months	Active Personnel			Reserve Personnel			Activity		Hours	Op Hrs	Equipment		Indirect	
Strategic		25	0%		2	0%		0	1.0		13.1	0.5	0%		0%	
Dwell 1		19	0%		2	0%		0	1.0		13.1	0.5	0%		0%	
Dwell 2		2	0%		2	0%		0	4.0		52.3	39.7	0%		0%	
Dwell 3		0	0%		2	0%		0	0.0		0.0	0.0	0%		0%	
Dwell 4		0	0%		2	0%		0	0.0		0.0	0.0	0%		0%	
Dwell 5		0	0%		2	0%		0	0.0		0.0	0.0	0%		0%	
Dwell		21	0%			0%			1.3		16.8	4.2	0%		0%	
Mob 1	Mob	1	0%		2	0%		0	4.0		52.3	39.7	0%		0%	
Mob 2	Bog	2	0%		2	0%		0	8.5		110.0	97.4	0%		0%	
Mob 3	Mob	1	0%		2	0%		0	1.0		13.1	0.5	0%		0%	
Mob	1:5.3	4	0%			0%			5.5		16.4	10.1	0%		0%	
Bog	1:11.5	2	0%			0%			8.5		55.0	48.7	0%		0%	
Rotational		25	0%			0%			2.0		71.4	58.8	0%		0%	
Available	Dwell 2	25	0%	0%	2	0%	0%	0	1.7	4.0	52.3	39.7	0%	0%	0%	0%
Deployed	24 Bog	25	0%		2	0%		0	3.0		39.3	26.7	0%		0%	
		12	0%			0%			1.0				0%		0%	

Figure 39. Reserve Component Resourcing and Activity Levels

Equipment replacement is modeled over a 40-year period at the authorized level for both Components. The estimate includes munitions procurement and assumes all indirect factors vary at 50 percent of their total cost with changes in the force structure.

2. Force Structure Cost and Flying Hour/Sortie Generation

Sortie (or flying hour (FH)) generation is the number of sorties (or flying hours) that can be produced given the specified activity levels and system characteristics, for both non-deployed and deployed operations. Sortie and FH are used interchangeably in the remainder of this section. Table 10 displays the cost and operational output for the selected A-10C force structure. Non-deployed operational sorties (or FHs), refer to operational sorties flown from home-station, such as training support to other forces. For modeling purposes, Table 10 assumes a non-deployed operational sortie lasts, on average, one and one half hours, and a deployed operational sortie lasts, on average, two hours. Cost is reported in millions of dollars per year, with both cost and capability appearing by unit category and in total. The selected force structure of 240 aircraft adds up to a total annual average cost in FY 2013 dollars of $2.25 billion.

Table 10. Notional Air Force Community Cost and Capability

System	Active Component					Reserve Component				
			Operational Sorties					Operational Sorties		
			Non-Deployed	Deployed				Non-Deployed	Deployed	
	Qty	Cost	Max	Max	Flown	Qty	Cost	Max	Max	Flown
Strategic	30	252	2,012	0	0	30	153	116	0	0
Available	45	445	5,838	4,875	0	45	380	3,565	2,104	0
Rotating	45	600	3,249	4,875	4,875	45	422	1,856	2,104	2,104
Deployed	0	0	0	0	0	0	0	0	0	0
Total	**120**	**1,297**	**11,099**	**9,750**	**4,875**	**120**	**955**	**5,537**	**4,208**	**2,104**

The difference between the sortie capacity (maximum operational sorties) and sortie generation (flown operational sorties) is the expected demand signal. The maximum sorties are the potential deployed sorties that would be generated if rotational aviation systems always deployed when they became available, plus the total number of deployed aviation system sorties. “Flown” operational sorties are the portion of the maximum deployed sorties executed by rotational aircraft plus the total number of deployed aviation system sorties. Table 10 shows these factors for the 240-system force structure. There is a total of 4,875 AC and 2,104 RC flown deployed sorties annually, along with 11,099 AC and 5,537 RC non-deployed operational sorties. This force structure would generate twice as many deployed sorties as it currently does if available units always deployed. This shows how the tool provides insight into the costs associated with different levels of output for a particular force structure.

3. A Graphical Display of the Community and Range of Units Alternatives

We present the Air Force output in multiple forms ranging from information on individual aviation system force structures to community-level cost and structural analysis. Systems are deployed according to the phase structure, the percentage of available units that deploy, and the operational and training activity levels specified by the user. This section focuses on displaying the cost of the community against different measures of output. The three measures include:

- Operational Non-deployed Sorties (or Hours): sorties (or hours) produced, or potentially produced, by a community when not deployed and classified operational—a function of the average number of non-deployed hours flown, the number of required training hours, and the number of required training hours tradable for operational hours.

NOTE: Operational non-deployed sorties (or hours) are not necessarily a useful measure for combat aircraft and are strictly a function of user assumptions regarding tradable training hours and the required minimum number of training hours relative to the program. Additionally, combat aircraft, including fighters, require full-spectrum training, and therefore usually should not have dwell training hours replaced by operational flight hours. They appear in the analysis of the A-10C in somewhat notional terms to provide insight into the types of variables that drive output in general.

- Operational Deployed Sorties (or Hours): sorties (or hours) produced by a community when deployed (AEF) and classified operational—a function of deployed activity level and the average number of non-deployed hours flown.
- Total Operational Sorties (or Hours): sorties (or hours) produced in total by a community if the sorties (or hours) are classified operational—the sum of the first two categories.

Note that within any of the displays in this section, the number of non-rotational aviation systems—strategic and deployed—is held constant. Strategic units generate costs and non-deployed operational capacity, but do not generate deployable potential. Deployed units generate both costs and deployable potential, but are treated as operating in a permanently deployed status. These aviation systems are considered to be “fenced” systems for this particular methodology. For purposes of simplicity, there are no deployed systems included in the analysis.

Figure 40 presents output for the community as indicated by the center point (blue). The display includes cost on the vertical axis and operational non-deployed sortie output on the horizontal axis. To provide greater detail, each major point is described:

- Point A – Community that is 100 percent AC and executes 100 percent of deployments.
- Point B – Community that is 100 percent RC and executes 100 percent of deployments.
- Point C – Community that is 100 percent RC and never deploys.
- Point D – Community that is 100 percent AC and never deploys.

The segment between points B and A depicts communities in which the portion of active aircraft varies between 0 percent and 100 percent and that execute 100 percent of deployments. Similarly, the segment between points C and D depicts communities in which the portion of active aircraft varies between 0 percent and 100 percent and that execute 0 percent of deployments.

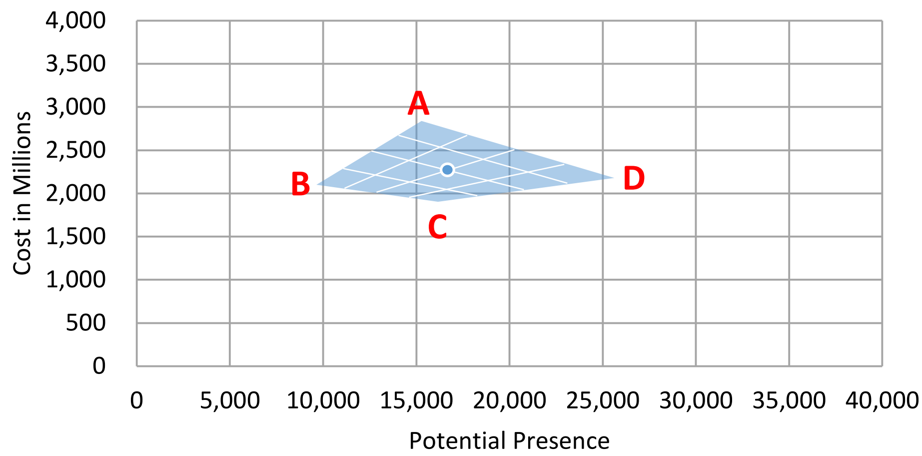

Figure 40. Aircraft Cost vs. Operational Non-deployed Sorties

The results shown are not unusual. Specifically, RC aircraft in our community generate fewer non-deployed operational sorties than AC aircraft. As such, shifts to a more AC-intensive force structure increase operational non-deployed output—while also increasing operational deployed output potential—and result in increased cost. This is a result expected for most cases; however, the difference between AC and RC might not be as drastic as expected. It is due to the assumptions that (1) the AC does not fly that much more than the RC during normal training and operations, (2) the AC requires more training hours, and (3) operational hours cannot always substitute for training hours.

Note in Figure 40 that the number of potential non-deployed operational sorties decreases as the number of deployments increases. For example, the number of potential non-deployed operational sorties falls from 25,480 to 15,124 in an all-AC force structure deployed during 100 percent of available periods. Understanding the decrease in non-deployed potential as actual deployments increase is important when considering the decrease in non-deployed mission availability. Such concerns are not limited to the Air Force. Both sea and land forces will incur a similar reduction in non-deployed potential operational output.

Figure 41 presents output for the same force structure, but measures output in terms of operational deployed sorties. This number of sorties is a function of the same modeling assumptions noted above. Similar to the other Services, this graph includes "potential" output—sorties executed given a specific community mix—and the four corners of the region represent meaning similar to Figure 40:

- Point A – Community that is 100 percent AC and never deploys.
- Point B – Community that is 100 percent AC and executes 100 percent of deployments.

- Point C – Community that is 100 percent RC and executes 100 percent of deployments.
- Point D – Community that is 100 percent RC and never deploys.

The segment between points C and B depicts communities in which the portion of active aircraft varies between 0 percent and 100 percent and that execute 100 percent of potential deployments. Similarly, the segment between points D and A depicts communities in which the portion of active aircraft varies between 0 percent and 100 percent and that execute 0 percent of potential deployments. Each of these lines represents a collection of endpoints for communities with specific mixes of AC and RC aircraft.

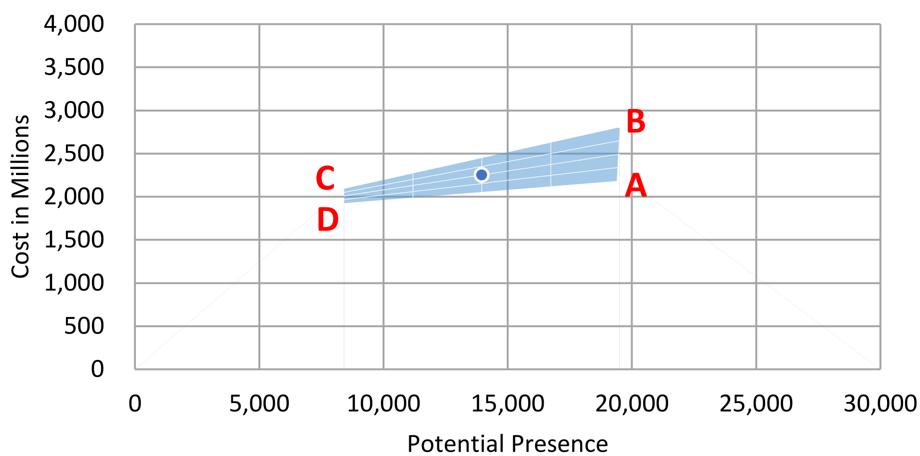

Figure 41. Aircraft Cost vs. Operational Deployed Sorties

Figure 42 and Figure 43 present costs and operational sorties (non-deployed and deployed) for a set of three communities. Both figures include a set of two alternative communities, with the original community displayed between the two alternatives. These displays are comparable to the multi-community displays for the other Services.

Figure 42 presents an expanded version of Figure 40, showing the decrease in potential non-deployed operational sorties as deployments increase. This behavior is an important consideration when designing a force structure and its rotational usage and resourcing. Understanding the simple relationship between measures of deployed and non-deployed output may be helpful, given a known requirement for non-deployed operations. A preferred force structure may change if non-deployed output is included.

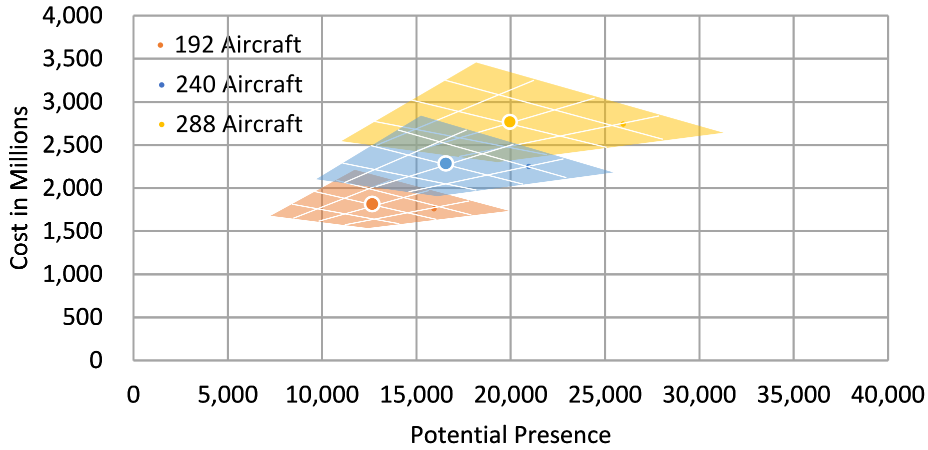

Figure 42. Aircraft Cost vs. Operational Non-deployed Sorties for Multiple Force Structures

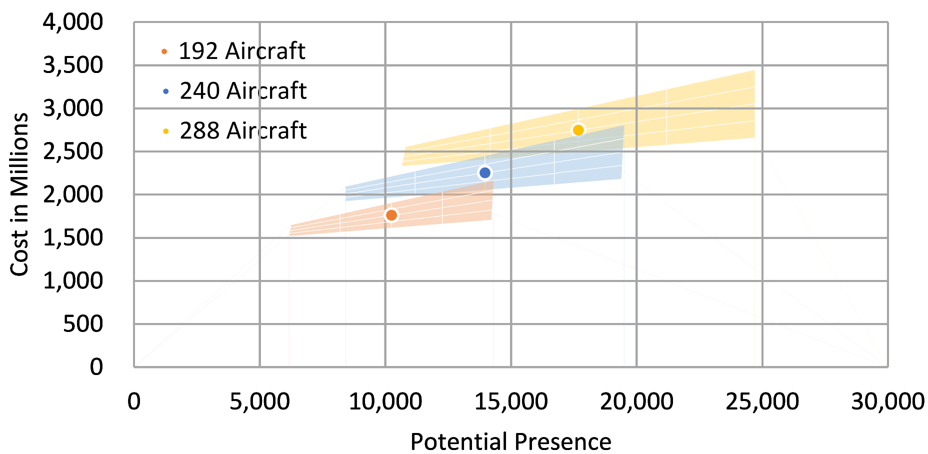

Figure 43. Aircraft Cost vs. Operational Deployed Sorties for Multiple Force Structures

The figures assist with quick visual comparisons of alternative force structures. We see that, for the assumptions made in our illustrative case, any of the three structures could provide 13,000 operational deployed sorties per year and that the smallest structure could do it most cheaply with a mostly Active force. However, if 288 aircraft, given a specific crew ratio, are needed for surge purposes, 13,000 operational deployed sorties per year could be flown alternatively with a more RC-intensive force.

5. Navy Modeling

A. Introduction

This chapter describes the Navy methodology and supporting tool. It starts with a description of data sources and treatment in Table 11. This is followed by sections on the major cost elements, assumptions, and inputs to the tool—selection of the community being analyzed, determination of force size and mix, definition of rotational patterns, resourcing, equipping, and treatment of indirect cost factors. The chapter concludes with a discussion of the primary Navy modeling outputs.

At this time we do not model most Navy force structure. We capture only those Navy units belonging to the Navy Expeditionary Combat Command (NECC). We draw heavily on work done for NECC by Booz-Allen-Hamilton. The resulting tool is quite similar to the Marine Corps tool described in Chapter 3.

B. Data Sources

Table 11. Primary Navy Data Sources

Category	Source
Personnel	OSD
Equipment Operations and Maintenance	NECC Capability Costing Model Navy VAMOSC
Procurement	Not Available
Indirect	FYDP
Deployment	IDA COST

C. Using the Model

A user must specify many inputs to define the force structure cases to be analyzed. The tool is constructed initially using Microsoft Excel and includes the following primary elements:

- Model inputs—items that the user can change—appear as blue text
- Locally calculated values—most model algorithms—appear as black text
- Linked calculated values appear as green text
- Important intermediate output—derived operational factors—appears as red text

- Primary output—cost and capability—appears as gray-on-gray text
- Explanatory text is shown in gray

1. Selecting Unit Type

Figure 44 displays the unit selection portion of the Navy tool.

Unit Selection	
Element	NECC
Unit Type	Construction
Unit	Naval Military Construction Battalion

Figure 44. Unit Selection Portion of Navy Tool

User must make choices in three categories. First the user selects the category of force structure **Element** being addressed. A drop-down menu provides only one choice currently: NECC. Second, the user selects a **Unit Type**. A number of unit types are available, including Construction, Support, and Explosive Ordnance Disposal. Third, the user must select a particular **Unit** within the unit type. The **Unit** drop-down menu offers units of the selected unit type, some at multiple echelons. This list of units changes with time and should be updated, at a minimum, on an annual basis. It includes approximately 40 units in the current version of the tool.

2. Selecting the Force Size and Mix Alternatives

Once the user selects the type of unit being analyzed, they must specify the force structure in terms of how many units are in the Active and Reserve Components. This involves choosing the number of AC and RC units and deciding how to distribute them among several options with regard to routine use. Figure 45 displays the force-structure portion of the Navy tool.

Units	**Active Component Units**		**Reserve Component Units**	
Strategic	1	0% +/-	1	0% +/-
Available	1	50% +/-	1	50% +/-
Rotating	1	50% +/-	1	50% +/-
Deployed	1	0% +/-	1	0% +/-
Unit Total	4		4	

Figure 45. Force Structure Portion of Navy Tool

The number of Active and Reserve units must be entered in four primary categories that imply different variations of operational use—Rotational Units (both Available and Rotating), and Non-Rotational Units (both Strategic and Deployed). Rotational units go through a cycle of preparing to be available for deployment. Sometimes this culminates in deployment and sometimes not. The user must specify the fraction of cycles that available units are expected to actually deploy by choosing the distribution of available and rotating units. Deployment involves additional costs. After the end of the availability or deployment period, rotational units typically go into a rest phase, followed by one or more phases of increased levels of training and readiness.

Deployed units are those permanently located outside of CONUS engaged in operations and that incur costs typical of a "long war." Both AC and RC units may be categorized as deployed; however, permanently deployed RC units are unlikely. That noted, RC forward deployed units could conceivably be maintained through a system of replacements. Users will likely want to provide deployed units with relatively high resource and activity levels as described in Section 5.C.5, "Setting Resource and Activity Levels."

Strategic units are at home station and do not prepare for rotational deployments. They operate at a steady-state level of resourcing without a phase structure and likely represent the minimum resource level for a unit. Either Active or Reserve units may be categorized as strategic. Users will likely want to provide strategic units with relatively low resource and activity levels as described in Section 5.C.5, "Setting Resource and Activity Levels."

3. Setting Dwell and Deployment Phase Structure for Rotational Units

The phase structure for rotational units is a central element in determining how much deployed presence can be generated from a given force structure. The periods during which units are not mobilized or deployed are termed "dwell." Users can specify up to five separate dwell phases, entering the number of months in each phase. Often, after a deployment or period of availability, a rotational unit will go into a reset or low-readiness phase, followed by one or greater higher readiness phases (dwell 2, dwell 3, etc.) while preparing for the next availability or deployment period. Figure 46 shows the entry screen for specifying the rotational pattern for Active units. The entry screen for Reserve units is identical to that for Active units.

Active Units			**Months**
Strategic			18
Dwell 1			2
Dwell 2			6
Dwell 3			2
Dwell 4			1
Dwell 5			0
Dwell			11
Mob 1		Mob	0
Mob 2		Bog	7
Mob 3		Mob	0
Mob		1:1.6	7
Bog		1:1.6	7
Rotating			18
Available		Dwell 3	18
Deployed	24	Bog	18
			0

Figure 46. Specification of Phase Structure for Rotational Units

The dwell period can be divided into up to five distinct phases with varying levels of readiness and resourcing. The deployment period can be divided into up to three phases. These may be used to model a deployment. They may also be used to model pre-deployment training, rest periods, transit time, and unit overlap time. The user can specify which phases in the deployment period contribute to operational capability by setting "BOG" time. A "MOB" (mobilized but not deployed) setting does not contribute to operational capability.

No phase structure is required for strategic or deployed units, since their resource and readiness levels are assumed to be constant, not cyclic. A strategic unit may be considered to operate at the minimum level of resourcing and a deployed unit at the maximum. The phase duration for strategic and deployed units is displayed as the sum of all the phases for rotational units. This is done for ease of computation. Phase options must be chosen separately for Active and Reserve units.

4. Defining the Mix of Active and Reserve Component Personnel

For both Active and Reserve units, the user can specify the proportion of billets in a unit filled by Active personnel. Figure 47 shows the input area for equipment and procurement. The bottom row addresses the personnel mix by specifying the proportion of personnel in the unit who are Active. The remainder is in the RC.

Equipment and Personnel		
Replacement Strategy	Auth	
Equipment Useful Life	30	
Include Ammunition	Yes	
Fuel Price	4.50	
Equipment Modification Rate	1%	◀ ▶
Active Personnel	100%	

Figure 47. Setting the Proportion of Personnel Who Are Active

5. Setting Resource and Activity Levels

Figure 48 shows the structure for specifying the resource and activity levels for strategic units, rotational units, and deployed units in every phase of their rotational cycle. Active and Reserve units must each be addressed separately. User input may be provided for four kinds of resources: personnel, O&M activities captured by the activity level, equipment, and indirect costs. Resource levels can be specified for both AC and RC personnel in all units, regardless of the unit's Component.

Active Units		Months	Active Personnel			Reserve Personnel			Activity		Equipment		Indirect	
Strategic		18	-30%		0	-30%		0	0.9		-20%		0%	
Dwell 1		2	-15%		0	-15%		0	1.0		-10%		0%	
Dwell 2		6	-10%		0	-10%		0	1.0		0%		0%	
Dwell 3		2	0%		0	0%		0	1.5		0%		0%	
Dwell 4		1	0%		0	0%		0	2.0		0%		+10%	
Dwell 5		0	0%		0	0%		0	1.0		0%		0%	
Dwell		11	-8%			-8%			1.2		-2%		+1%	
Mob 1	Mob	0	0%		0	0%		0	2.0		0%		+10%	
Mob 2	Bog	7	0%		0	0%		0	3.0		0%		+10%	
Mob 3	Mob	0	0%		0	0%		0	2.0		0%		+10%	
Mob	1:1.6	7	0%			0%			3.0		0%		+10%	
Bog	1:1.6	7	0%			0%			3.0		0%		+10%	
Rotating		18	-5%			-5%			1.9		-1%		+4%	
Available	Dwell 3	18	-5%	0%	0	-5%	0%	0	1.3	1.5	-1%	0%	+1%	0%
Deployed	24 Bog	18	0%		0	0%		0	2.5		0%		+10%	
		0	0%			0%			2.5		0%		0%	

Figure 48. Setting Resource and Activity Levels

The default setting for Active and Reserve personnel levels is 0 percent. This indicates zero deviation from the TOE level of personnel for a fully-resourced unit. By entering a new number, the user causes the calculation of personnel costs to change by the specified percentage. Entering a positive number or negative number increases or decreases personnel costs by the indicated percentage, respectively. After a unit returns from deployment, members of the unit may leave for a variety of reasons—their enlistments end, they return to inactivated status, they go back to school, or are reassigned. Therefore, it is reasonable to account for units that may not be fully manned. In addition, units may be manned to higher levels during periods where higher readiness is necessary.

The treatment of equipment and indirect costs is similar to that of personnel. The default level of 0 percent for equipment indicates that the quantity of equipment on hand is that specified in the organization's TOE. During dwell periods, total equipping less than 100 percent is likely. The default level of 0 percent for Indirect indicates that the unit generates a typical amount of indirect cost during that phase. Changing the amount of equipment on hand adjusts the amount of equipment used in training and thus affects operating costs. Changing the amount of equipment may also have an impact on procurement costs.

The default setting for activity level is 1.0. This is assumed to be the normal level of activity for a fully ready unit. The user may enter a lower or higher number to indicate lower or higher OPTEMPO. The activity level set indicates how much a unit is training or operating relative to the normal peacetime level. This level drives pay for units in the RC—higher activity increases RC training days—as well as operating costs and equipment replacement costs. Operating costs during the specified phase or for deployed or strategic units are modified according to the factor entered. Operating costs depend on both the amount of equipment on hand and the activity level applied to that equipment.

6. Choosing Equipment Assumptions

Equipment and ammunition replacement costs are affected by the Procurement Strategy, Equipment Life in Years, Ammunition Replacement, and the Equipment Modification Rate. These inputs are specified in "Equipment and Personnel" for Active and Reserve units to the right of "Resource and Activity Levels." Figure 49 displays the structure for specifying equipment replacement cost inputs.

Equipment and Personnel	
Replacement Strategy	Auth
Equipment Useful Life	30
Include Ammunition	Yes
Fuel Price	4.50
Equipment Modification Rate	1%
Active Personnel	100%

Figure 49. Setting Equipment Replacement, Ammunition, and Modification Inputs

Procurement Strategy is selected from a drop-down menu containing the choices "Auth" (Authorized), "Avail" (Available), or "None." "Auth" indicates replacement at an authorized level of equipment rate, "Avail" means replacement at an on-hand equipment rate, and "None" excludes equipment replacement costs from our calculations, under the implicit assumption that it is not a function of force-mix decisions.

Equipment Life in Years is the rate in years over which equipment will be replaced, on average. The tool assumes a 1.0 activity level represents one year of equipment replacement as the default for the selected procurement strategy. The entry in the **Equipment Life in Years** input affects the rate at which equipment is replaced, and therefore the equipment replacement costs. The user may choose whether or not to include ammunition in procurement costs in the third input field under **Equipment and Personnel** (**Include Ammunition**). Ammunition costs are a function of equipment resourcing and the activity level. Including ammunition will change the total annual procurement costs.

Fuel prices may be set in the **Fuel Price** input field in dollars per gallon. **Equipment Modification Rate** is the final input field related to equipment operating and replacement costs. It indicates the percentage of the total acquisition cost of the unit necessary to fund typical O&M-funded modifications. It funds both hardware and software modifications. This is typically between 0 percent and 5 percent on an annual basis and is included in O&M costs.

7. Modeling Indirect Costs

Indirect cost factors such as Installation Support, Personnel Administration, Personnel Benefits, Medical Care, and General Training and Education can be specified by the user. Figure 50 displays the area where **Indirect Factors** are set.

Indirect Factors	
Installation Support	50%
Personnel Administration	50%
Personnel Benefits	50%
Medical Care	50%
General Training and Education	50%

Figure 50. Indirect Costs

Indirect costs are based on three years (2009–2011) of historical spending from the FYDP. They are targeted for annual updates on a rolling basis. Indirect costs are calculated as the cost per person for the AC, or as the cost per effective FTE for the RC. The inputs shown in Figure 50 set the percentage of total indirect costs that will be treated as marginal with changes in the force structure. The default assumption within the tool, sometimes used within DoD, is to set indirect costs as 50 percent variable with changes in personnel. For example, a 10 percent reduction in AC personnel will, according to the accounting rules described herein, reduce “Installation Support” by 5 percent for the AC.

Many factors may be relevant when determining the portion of indirect costs—and all costs—that change with the force structure. A selection of relevant factors might include:

- Timeframe of the analysis
- Magnitude of the change in force structure
- Category of indirect cost element (five in our tools)
- Type of unit or manpower driving the change

We focus discussion on the timeframe of the analysis: the duration over which the modeling results will be applied. Consider, for example, how cost savings will differ in the short term and long term due to force structure increases. For a short timeframe, only direct costs are likely to change—personnel costs, equipment operating costs, and limited procurement costs. It is not likely that indirect costs would change to the same magnitude, if at all. As the timeframe of the analysis increases, direct costs would continue to be affected in a similar fashion; however, an increasing portion of indirect costs would likely be affected. Taken to the extreme, permanent long-term increases in force structure will likely generate marginal changes in indirect costs approaching 100 percent variable. In this case, the user may choose to select all indirect costs as 100 percent variable.

8. Including Other Costs

Other costs include special training events, modernizations, transition hurdles, prepositioning stocks, and other similar undertakings. These costs cannot be easily integrated into a simple tool, and are not reliably estimated using averages. They may, however, be worth including if they are well known or the user would like to experiment with alternative unit costs. Thus, this function can be used as a "catch all" in order to capture additional, alternative, or unique costs. It is up to the user to identify and input these events. As shown in Figure 51, these costs can be a function of almost any cost driver; e.g., the number of personnel, the unit type, or the duration of the phase cycle.

Description	Scenario	Unit	Personnel	Phase	Metric	Value
Event 1	Default	Strategic	N/A	N/A	$/Unit	0
Event 2	Default	Strategic	N/A	N/A	$/Unit	0
Event 3	Default	Strategic	N/A	N/A	$/Unit	0
Event 4	Default	Strategic	N/A	N/A	$/Unit	0
Event 5	Default	Strategic	N/A	N/A	$/Unit	0
Event 6	Default	Strategic	N/A	N/A	$/Unit	0
Event 7	Default	Strategic	N/A	N/A	$/Unit	0
Event 8	Default	Strategic	N/A	N/A	$/Unit	0
Event 9	Default	Strategic	N/A	N/A	$/Unit	0
Event 10	Default	Strategic	N/A	N/A	$/Unit	0

Figure 51. Other Costs

Accounting for these possibilities in a tool makes it simple to add extra costs. A modeler should consider factors such as the type of unit, the CONOPS, the cost-driving metric, and cost factor source when adding other costs. Allowing alternative possibilities to be considered when modeling unit costs provides important flexibility. For example, a unit that must report to a training center before it deploys may require an additional per person cost during its final dwell phase. The **Other Costs** functionality could be used to handle such a unit-specific requirement.

D. Standard Outputs

1. Introduction

This section discusses the outputs the tool produces. The figures and tables are based on a specific set of inputs and assumptions chosen for this particular analysis. We have selected a typical Navy Construction Battalion for the illustrative analysis shown in Table 12. The initial force structure includes the set of characteristics and assumptions shown in Table 12.

Table 12. Notional Navy Community

Infantry BN	Active Component		Reserve Component		Total
	Quantity	Range of Alternatives	Quantity	Range of Alternatives	
Strategic	0	+/-0%	4	+/-0%	4
Available	4	+/-25%	4	+/-25%	8
Rotating	4	+/-25%	4	+/-25%	8
Deployed	0	+/-0%	0	+/-0%	0
Total	**8**		**12**		**20**

Note: Assumes~600 Sailors per Battalion.

Key inputs to the tool include Active and Reserve Component phases, BOG-to-dwell ratios, MOB-to-dwell ratios, resourcing levels, and activity levels. These appear in the tool as shown in Figure 48 and Figure 52. Settings for this analysis include:

- Active BOG-to-dwell of 1:1.6 and Reserve MOB-to-dwell of 1:5
- Deployed activity rate of 3.0 for the AC and 3.5 for the Reserve
- Increased indirect costs during mobilization and deployment of 10 percent
- Equipment replacement costs are ignored
- Equipment modification costs of 1 percent of asset value per year
- Fuel price of $4.50 per gallon in the modeled base year

- Reserve units including 10 percent Active-Reserve
- Included ammunition procurement linearly variable with the activity rate
- Indirect costs variable at 50 percent with the number of personnel

Reserve Units		Months	Active Personnel			Reserve Personnel			Activity		Equipment		Indirect	
Strategic		72	-30%		29	-30%		541	0.9		-20%		-10%	
Dwell 1		6	-15%		34	-15%		658	0.8		-10%		0%	
Dwell 2		30	-15%		34	-15%		658	1.0		-5%		0%	
Dwell 3		24	0%		40	0%		774	2.0		0%		+20%	
Dwell 4		0	0%		40	0%		774	1.0		0%		0%	
Dwell 5		0	0%		40	0%		774	1.0		0%		0%	
Dwell		60	-9%			-9%			1.4		-4%		+8%	
Mob 1	Mob	5	0%		40	0%		774	2.5		0%		+10%	
Mob 2	Bog	7	0%		40	0%		774	3.5		0%		+10%	
Mob 3	Mob	0	0%		40	0%		774	2.5		0%		+10%	
Mob	1:5.0	12	0%			0%			3.1		0%		+10%	
Bog	1:9.3	7	0%			0%			3.5		0%		+10%	
Rotating		72	-8%			-8%			1.7		-3%		+8%	
Available	Dwell 3	72	-8%	0%	40	-8%	0%	774	1.5	2.0	-3%	0%	+10%	+20%
Deployed	24 Bog	72	0%		41	0%		773	3.5		0%		+10%	
		0	0%			0%			1.0		0%		0%	

Figure 52. Reserve Component Resourcing and Activity Levels

2. Force Structure Cost and Rotational Capability

Combining the chosen force structure with the selected inputs produces an estimate of two major factors: cost and operational capability. The strategic capacity is defined as the number of units in the force structure; in this case, 20. This estimate appears in Table 13 and is shown in a similar format to the tool. Cost is reported in millions of dollars per year with both cost and capability appearing by unit category and in total. The selected force structure of 20 battalions—eight AC and 12 RC—costs $1.47 billion in FY 2012 dollars annually.

Table 13. Notional Navy Community Cost and Capability

INF BN	Active Component				Reserve Component			
	Qty	Cost	Max BOG	BOG	Qty	Cost	Max BOG	BOG
Strategic	0	0	0.00	0.00	4	100	0.00	0.00
Available	4	376	1.56	0.00	4	158	0.39	0.00
Rotating	4	581	1.56	1.56	4	253	0.39	0.39
Deployed	0	0	0.00	0.00	0	0	0.00	0.00
Total	**8**	**957**	**3.11**	**1.56**	**12**	**511**	**0.78**	**0.39**

Note: INF – Infantry.

The "Max BOG" is the potential operational BOG, on an annual basis, generated for all AC and RC units. "BOG" is the portion of the "Max BOG" generated by units that actually deployed. Table 13 shows the specified 20-unit force structure generating a total of 1.95 BOG years on an annual basis. The four AC units generate 1.56 units of BOG with the RC units generating the remaining 0.39 units. The "Max BOG" for the entire community is 3.89 with the force mix utilizing 1.95 units of annual BOG.

3. A Graphical Display of the Range of Units and Community Alternatives

This section presents sample graphs for the chosen force structure and a range of force-mix alternatives in a bounded region. We present the output in the same manner as the figures in the Introduction chapter. Specifically, we include a display of the point estimate reported above as a red point and its associated optionality in Figure 53, and a range of alternatives analysis that varies the number of rotational units by +/-50 percent in Figure 54. As can be seen in Figure 53, increasing the percentage of AC units increases costs and operational presence.

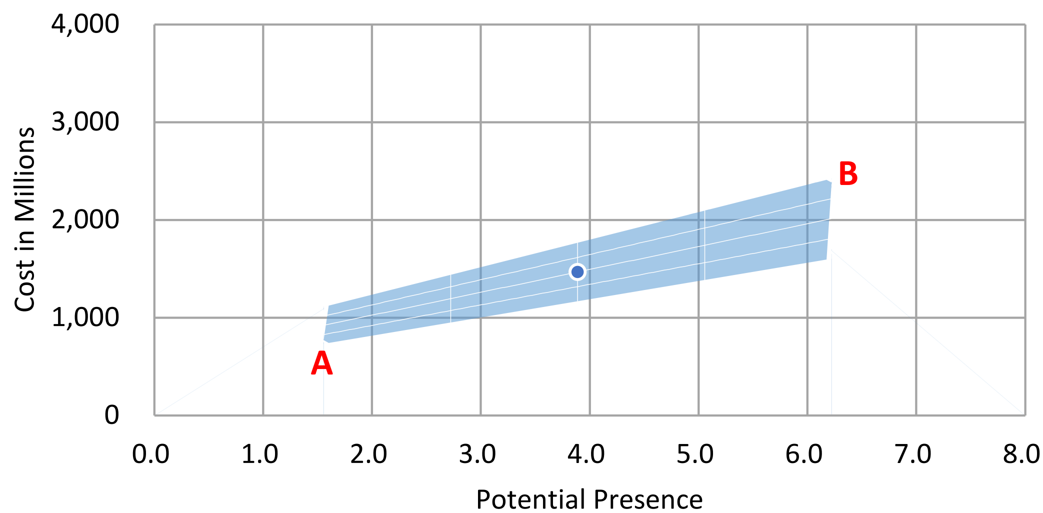

Figure 53. Point Estimate and Rotational Unit Optionality

The chosen force structure ranges between approximately 1.6 and 6.3 of potential operational presence and between $760 million and almost $2,300 million in cost. In years with no deployment requirement, costs might decrease as much as 30 percent relative to years where deployment demand is high.

Point A and Point B represent the extreme force-mix alternatives for the region. Both points include 20 units of strategic capacity. Point A would be a force mix of 100 percent RC, 1.6 units of operational capacity, and a cost of $760 million. Point B is a 100 percent AC community, 6.2 units of operational capacity, and a cost close to $2,300 million. Figure 54 expands on Figure 53 to include potential alternative force structures that add and remove four rotational units of each Component.

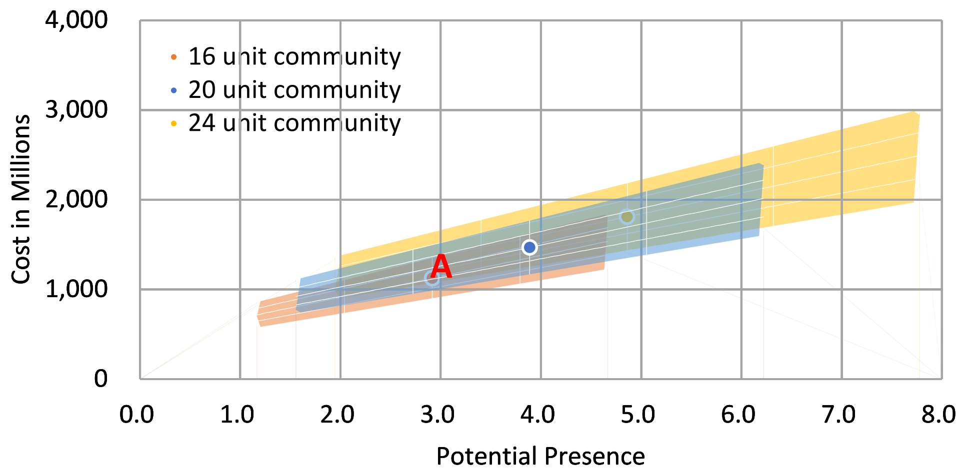

Figure 54. Point Estimate with Current and Alternative Force Structures

In the case shown in Figure 54, larger force structures with a greater proportion of RC units provide increased strategic capability for slightly greater cost if deployed and similar cost if not deployed. Point A falls in the range of all three force-mix structures. For each structure (16, 20 and 24) Point A costs $1,200 million and provides approximately 3.0 of operational presence. The difference is in the AC-RC mix and strategic capacity. The 16-unit structure is slightly AC-heavy, but carries only 12 units of strategic capacity. The 20-unit structure is approximately a 30/70 Component mix, while the 24-unit structure provides extreme strategic capacity of 24 units while limiting their operational capability with an RC-heavy Component mix. The RC-heavy force structures provide primarily increased strategic capability as their main advantage. The moderately negative slope of the regions shows the level of savings when trading AC for RC units. In this case, RC units do not provide as great operational savings as they might otherwise because of a conservative usage pattern.

6. Concluding Review

This paper describes a set of methods and related tools developed to allow the incorporation of cost into wider force-structure decisions involving the mix of AC and RC units. We have developed this methodology and set of tools to facilitate comparison of alternative AC-RC force mixes for OSD, the Joint Staff, and the Services. The paper is meant to familiarize individuals with the important components of force-mix and force-structure modeling, and potential users with the development and use of the associated tools. No recommendations regarding any particular force-mix alternative are provided.

The method introduced permits quick comparison of several alternative force mixes with respect to cost, strategic capacity, and operational capacity. Our approach is to help decision makers find the best applicable AC-RC mix that can:

- Include acceptable surge capacity, as measured by total force size including strategic, rotational, and deployed units or systems
- Attain acceptable steady-state operational or presence levels, as measured by the number of units a force of a specified size and AC-RC mix can maintain to support potential deployments on a continuing basis

The first key element of our approach is to focus the analysis at the community level, where AC-RC force-mix decisions are made. The tool allows the user to consider the costing analysis in the context of the CONOPS for the entire community over a multi-year period. Focusing on the cost of individual units or the cost of deploying a single unit from either the AC or RC does not address outputs from the utilization of the entire community. However, an integrated analysis of multiple alternative mixes of all AC and RC units in the community gets to the heart of being able to determine the most efficient mix that has acceptable operational and strategic risk. As part of this analysis, we believe four key non-rotational and rotational unit types are worth considering: strategic, deployed, available, and rotating.

Second, we consider cost together with basic measures of capability: surge capability (measured by community size) and routinely generated operational capability. In the case of the Army and Marine Corps, deployed operational capability is measured by potential presence. For the Air Force, operational capability is measured by non-deployed operational capability and deployed operational capability in hours or sorties. The concept of non-deployed operational capability, although not addressed explicitly for ground forces, is relevant defense-wide, especially regarding possible use for disaster relief or homeland defense missions.

Third, we provide flexibility with respect to the management of readiness. Units can be managed according to cyclic or tiered readiness paradigms. They can be rotational, permanently deployed, or in a strategic reserve. Deployed units count as operational presence, given their high OPTEMPO and implied forward location. The deployed unit rather represents the marginal gain of full versus partial presence compared to a rotational unit. At times, deployed units or systems may be described as "fenced."

Finally, to the greatest extent possible, the model reflects all cost elements relevant to the marginal cost of owning and operating units. The flexible treatment of indirect costs with respect to changes in the number of units is an example of this analytical completeness. Related to this point is the way in which we link cost of the community, or unit, to the capability it provides. Strategic units are suggested to be modeled as units manned, resourced, and trained at minimal levels designed to support only the surge requirement. In that respect, the cost of a strategic unit is regarded as the minimum cost of *any* unit in the force structure. Therefore, the cost of adding capability, both non-deployed and deployed, to a specific unit, is the difference in cost between a strategic unit and the modeled rotational or deployed unit. This difference in cost thus may be termed the marginal cost of a given additional capability for either a single unit or the community in its entirety. Applying this concept is important in understanding the value and cost that changes in training and readiness can provide.

The illustrated methodology for comparing AC-RC force-mix alternatives gives insights into the costs and capabilities associated with selected alternatives, but it is incomplete. It should be considered and used with the following caveats in mind:

- The Service-level models differ in their coverage. All kinds of operating units are included for the Army and Marine Corps, although elements of the non-deploying infrastructure (like fixed training organizations and management organizations) are not. The Air Force model only includes flying units. The Navy only includes those forces that are under the NECC.
- Transition (that is, unit conversion) costs are not considered. Changes in the mix of Active and Reserve units take time and entail costs.
- The rate at which surge forces can be generated is not addressed.
- Some cost factors that we take to be constants may not be, for substantial shifts in AC-RC mixes for large communities. Training costs are an example.
- Differences in effectiveness between AC and RC units are not addressed.

Illustrations

Figures

Tables

References

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Abbreviations

AAV	Assault Amphibious Vehicle
ABCT	Armored Brigade Combat Team
AC	Active Component
ACC	Air Combat Command
ACE	Aviation Combat Element
AEF	Air and Space Expeditionary Force
AFEMS	Air Force Equipment Management System
AFI	Air Force Instruction
AFRC	Air Force Reserve Command
AFTOC	Air Force Total Ownership Cost
ANG	Air National Guard
ARC	Air Reserve Component
ASAF	Assistant Secretary of the Air Force
BMC	Basic Mission Capable
BN	Battalion
BOG	Boots on the Ground
CE	Command Element
CMD	Command
CMR	Combat Mission Ready
COLA	Cost of Living Allowance
CONOPS	Concept of Operations
CONUS	Continental United States
COST	Contingency Operations Support Tool
DoD	Department of Defense
FH	Flying Hour
FM&C	Financial Management and Comptroller
FTE	Full-Time Equivalent
FTS	Full-Time Support
FY	Fiscal Year
FYDP	Future Years Defense Program
GCE	Ground Combat Element

H&S	Headquarters and Support
IBCT	Infantry Brigade Combat Team
IDA	Institute for Defense Analyses
INF	Infantry
LAR	Light Armored Reconnaissance
LCE	Logistics Combat Element
MAJCOM	Major Command
MARFORCOM	Marine Forces Command
MDS	Mission Design Series
NECC	Navy Expeditionary Combat Command
MOB	Mobilization Period
O&M	Operations and Maintenance
OPTEMPO	Operating Tempo
OSD	Office of the Secretary of Defense
OUSD	Office of the Under Secretary of Defense
PA&E	Program Analysis & Evaluation
PAA	Primary Aircraft Assigned
PCS	Permanent Change of Station
PE	Program Element
RAP	Ready Aircrew Program
RC	Reserve Component
RTM	RAP Training Manual
SBCT	Stryker Brigade Combat Team
SRC	Standard Requirement Code
TFSMS	Total Force Structure Management System
TOE	Table of Organization and Equipment
UTC	Unit-Type Code
VAMOSC	Visibility and Management of Operating and Support Costs

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14. ABSTRACT

This paper describes tools developed for incorporating cost into force-structure decisions involving a mix of Active Component (AC) and Reserve Component (RC) units of particular types in all the Services. Determining the best mix of Active and Reserve units is an important element of defense planning and force sizing. Active units are often better able to deploy on short notice than Reserve units, and can be deployed more frequently. Reserve units, on the other hand, are less expensive on a unit-for-unit basis, allowing a larger force structure to be maintained for a given level of expenditure. We developed this methodology and set of computer-based tools to facilitate comparison of alternative force mixes for the Office of the Secretary of Defense, the Joint Staff, and the Services. The method permits quick comparison of several alternative force-mixes with respect to cost and strategic and operational capacity. A key element of this approach is an analysis at the community level—the set of units of a given type—that considers cost over multiple years. User inputs include force levels by Component, use and rotation patterns, resource and activity levels, equipment replacement costs, and indirect costs. The tools do not address the speed with which a given force structure can respond to a surge in requirements, nor do they consider differences in effectiveness between Active, Reserve, and National Guard units of a particular type.

15. SUBJECT TERMS

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