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Executive Summary

The Department of Defense (DoD) is responsible for preparing the Armed Forces for a future that is fundamentally uncertain—indeed, that is unknowable. DoD has typically assessed future needs and capabilities based on representative planning scenarios. This approach has the strength of providing a common focus across DoD on a few agreed upon situations. However, such an approach has limitations, because decision making in the face of uncertainty requires evaluating implications across a distribution of possible future events. The Institute for Defense Analyses' Stochastic Active-Reserve Analysis (SARA) model is intended to augment DoD's existing formal planning construct as a tool for assessing alternative force structures that can provide an analytical basis for DoD resource allocation decisions.

This model was originally built for the Office of the Secretary of Defense, Cost Assessment and Program Evaluation (OSD CAPE) with the intention of analyzing the tradeoffs between alternative active-reserve mixes when demand is uncertain. However, it can be used to examine many total force mix issues. We constructed the model as a framework in which a user provides inputs that answer several questions. On the demand side, the questions include the following:

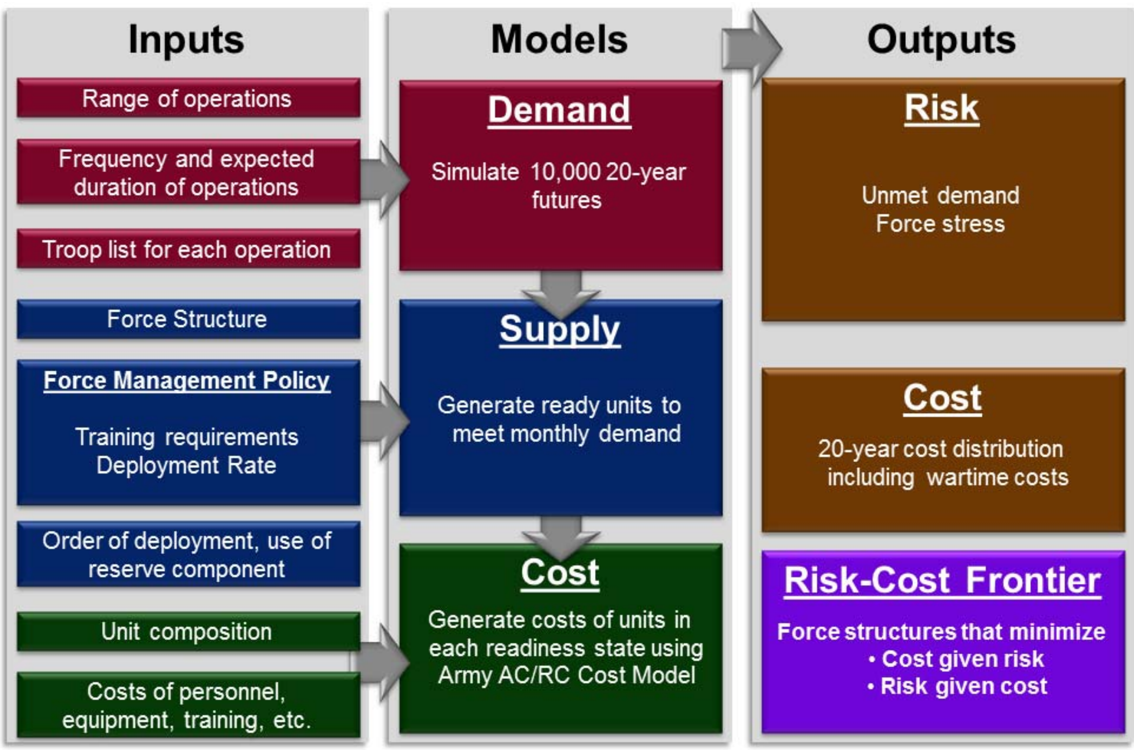
- What do you think will happen in the future?
- How likely is each contingency?
- What force list is required to deal with each contingency?

On the supply side, the questions include the following:

- How big is your force?
- What mix of forces are you planning for?
- How do you plan to manage your force?
  - What are your mobilization policies?
  - What are your rotation policies?
  - How do you structure your training pipeline? Under what conditions would you shorten the pipeline?
  - What are the relevant costs?

The model then uses these inputs to simulate 10,000 20-year futures and supplies the available forces to meet the varied requirements for each future. The model keeps track of the shortfalls in each future as well as the dwell- and deployment-related costs, allowing us to demonstrate the tradeoffs between cost and risk (measured as unmet demand). In addition to cost and risk, the model also tracks force stress. The figure below provides an overview of the components of the SARA model.

Since the demand framework is not limited to only a few scenarios, SARA allows you to explore alternative views of the future (different mission sets, probabilities), extreme events that reveal the consequences of guessing wrong, and tailored scenarios for specific planning objectives. Similarly, the flexible supply model allows exploration of a variety of mixes, alternative readiness postures (e.g., rotating vs. maintaining a fixed readiness level), alternative rotation rates, and alternative deployment lengths. In short, the SARA model provides a way to evaluate a wide range of defense postures in an era of vast uncertainty about what US military forces will be called on to do.



SARA Model Overview

Contents

1. Introduction

The Department of Defense (DoD) is responsible for preparing the Armed Forces for a future that is fundamentally uncertain—indeed, that is unknowable. DoD has typically assessed future needs and capabilities based on representative planning scenarios. This approach has the strength of providing a common focus across DoD on a few agreed upon situations. However, such an approach has limitations, because decision making in the face of uncertainty requires evaluating implications across a distribution of possible future events. The Stochastic Active-Reserve Analysis (SARA) model is intended to augment DoD's existing formal planning construct with a tool for examining the implications of uncertainty in sizing and managing military forces.

The SARA model is designed to answer such questions as

- How do the magnitude and likelihood of future demands for military units vary, given alternative schools of thought regarding future world conditions, military strategy, and force planning assumptions?
- How would the available supply of deployable military units vary, depending on alternative programs and policies regarding force structure, Active-Reserve mix, readiness, and force management policies? What are the associated costs?
- Under what circumstances would the supply of forces be sufficient to meet demands? How common and how large are projected shortfalls in specific units?

The Office of the Secretary of Defense (OSD)'s Cost Assessment and Program Evaluation (CAPE) organization asked the Institute for Defense Analyses (IDA) to develop the SARA model with the expectation that DoD will face a number of decisions over the coming decade that could benefit from careful analysis. Today, the major pending decisions relate to the drawdown of the Services' end strengths. Future choices will be posed by ongoing budget pressures, world events, new technologies, and the new National Security Strategy. CAPE believes that investments in the SARA model's analytical capability will help inform and supplement DoD's decision-making processes, resulting in a more cost-effective total force. The SARA model can serve five important management functions:

- Providing a common starting point for conducting analyses of alternative Active component (AC) and Reserve component (RC) structure, readiness, and force management policies;

- Facilitating communication within and across DoD—SARA provides unclassified planning cases combined with a common set of assumptions, rules, and data;
- Assessing the implications of uncertainty for DoD force planning;
- Illustrating and explaining Service differences in structuring and managing Active and Reserve forces; and
- Providing a "test bed" for creating and evaluating ideas, both for the purposes of policy and program development and potentially for educational applications.

The development of the SARA model continues CAPE's efforts to create a more systematic approach for framing and assessing Active and Reserve force structure and force management choices. In a DoD report to the Congress, CAPE outlined common principles for balancing AC and RC forces and reported on current Service structures within this framework. The SARA model represents an important additional step toward establishing common assumptions, definitions, rules, data, and analytical approaches. Within this common framework, the SARA model offers the flexibility to handle alternative schools of thought regarding future operational demands and the various management approaches currently employed by the Services. The SARA model generates assessments of the costs and shortfalls in force structure associated with a wide range of "what-if" policy and programmatic alternatives based on user-selected inputs to the common framework.

This paper describes the SARA model. Where appropriate, examples are cited using SARA Version 2.0, which was completed in July 2013 and models Army brigades in the General Purpose Force (GPF).

2. Methodology

A. Three Models

In this chapter, we describe the methodology of the SARA model. While SARA Version 2.0, described in this paper, only simulates the Army,[1] the stochastic approach to force modeling could be used effectively for any of the Services (with appropriate modifications to account for differences in how the Services manage and deploy their forces.) In Chapter 3, we provide an example application of this methodology using notional Army data. The SARA model comprises three individual models: a demand model that generates requirements for forces, a supply model that manages these forces, and a cost model that keeps track of the financial cost of these forces. Figure 1 provides an overview of the SARA model framework.

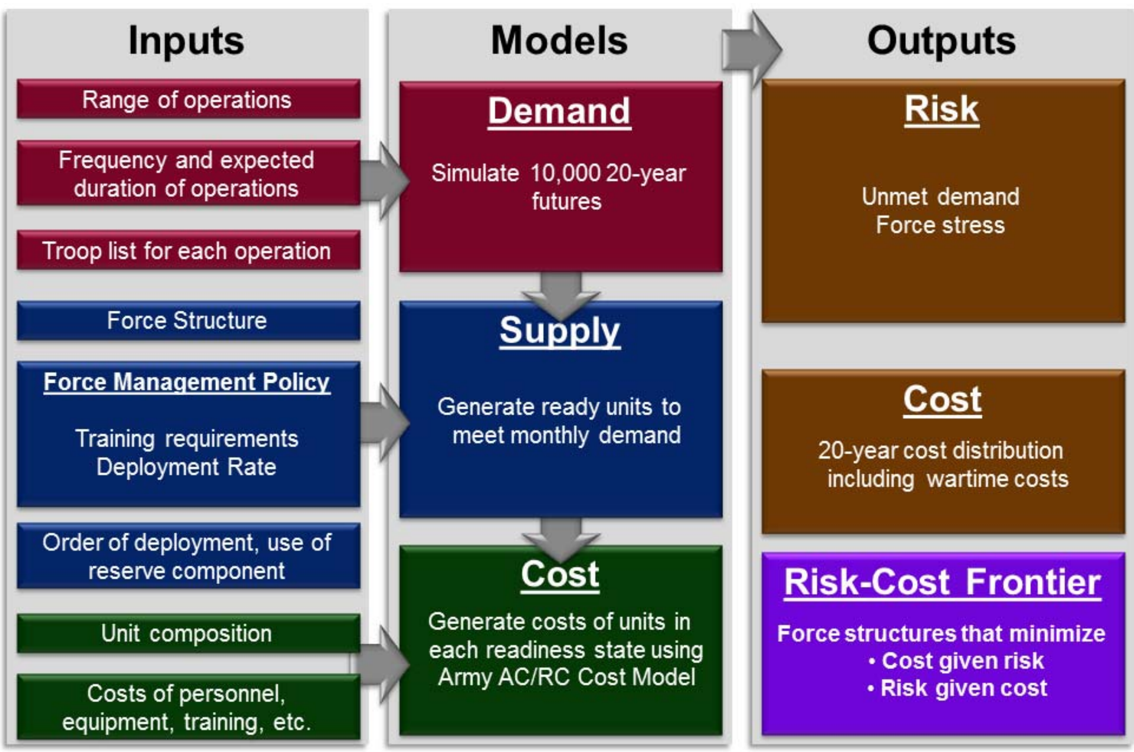


Figure 1. SARA Model Overview

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1 IDA has also built a prototypical version for the Marine Corps that is not described in this paper.

Each of the three individual models performs analysis at the unit level. To use the SARA model, the user must first decide which types of units to analyze and at what level (e.g., brigade, battalion, company). In our example in Chapter 3, we choose to model all of our notional units at the brigade level. However, the SARA model can incorporate unit level as long as it is inseparable, i.e., the whole unit trains and deploys together. Since the SARA model runs independently for each unit type, it is possible to evaluate some unit types at different levels. All units of a single type (e.g., Brigade Combat Teams, or BCTs) must be evaluated at the same level.

B. Stochastic Demand Model

We define a model "future" as a series of T discrete time periods. Conceptually, the model can accept any discrete time period as the unit of time, but in practice, the number of discrete units of time in any given future is constrained by computing power. In our example in Chapter 3, we model a 20-year future as a series of discrete months. Hereafter, we refer to the individual time periods as "months" for simplicity.

Demand for units is generated by a set of P types of randomly occurring *operations*. Users choose the number of operation types to simulate and specify four characteristics of each operation type (described in the next section). The total number of units required in each month is the summation of required units in each of the ongoing operations.

1. Defining an Operation

An operation is defined by four inputs: expected starting frequency, the number of stages, the duration of each stage, and the required number of units in each stage. First, a user defines the starting frequency of an operation by entering $\Lambda_p \in \mathbb{R}$—the expected number of operations of type p that will start in a future (e.g., in 20 years)—for each operation type. (Define $n_{tp} \in \{0, 1, 2, \dots\}$ as the number of operations of type p that *start* in month t.) We assume that n_{tp} is a Poisson random variable such that the probability of drawing any n_{tp} is defined by $f_P(n_{tp}) = F_P(n_{tp}, \lambda_p)$ where F_P is the Poisson probability mass function and $\lambda_p = \frac{\Lambda_p}{T}$.[2]

Each operation consists of $S \in \{1, 2, \dots\}$ sequential stages. Each stage s is defined by the number of units required and a probability distribution $F_D(d_{sp})$, where $d_{sp} \in \{1,2, \dots\}$ is a random variable equal to the duration of stage s of operation type p in months. At the end of each stage, either the next stage begins or—if there are no more stages remaining—the operation ends.

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[2] Note that since the sum of Poisson random variables is a Poisson random variable with mean equal to the sum of the means of the added variables, the distribution of operations of type p in the model is described by $f_P(N_{ip}) = F_P(N_{ip}, \Lambda_p)$, where $N_{ip} = \sum_{t=1}^{T} n_{tp}$ is the total number of type p operations that begin in future i.

The final input that defines an operation is u_{spj}, which is the number of type j units required in stage s of operation p. Hence, the total requirement for type j units in month t of future i is

$$U_{itj} = \sum_{p=1}^{P} \sum_{s=1}^{S_p} v_{itsp} u_{spj}, \quad (1)$$

where v_{itsp} is the number of ongoing type p operations in stage s at month t of future i. The SARA model assumes that, given that an operation occurs, the unit requirements are known. In practice, it is straightforward to introduce some uncertainty into the requirements by defining two similar operations that differ (for example) only in the size of the requirements and adjusting the associated frequencies. For example, to create a counter-insurgency campaign (COIN) of two sizes, one could define operations 1 and 2 such that $u_{s1j} > u_{s2j}$ for at least one s and one j and $\lambda_1 + \lambda_2 = \lambda_{COIN}$.

Table 1 summarizes the demand model inputs. In Section 3.A, we provide an example of a demand simulation based on historical operation frequencies.

Table 1. Demand Model Inputs

Input	Description
P	Number of operation types
Λ_p	Expected number of type p operations in a single future
S_p	Number of stages in a type p operation
$F_D(d_{sp})$	Probability distribution of duration of stage s of a type p operation
u_{spj}	Number of type j units required in stage s of a type p operation

2. Initial Conditions

We identified two reasonable approaches for setting the starting conditions of the demand model: either the starting conditions could reflect whatever operations are ongoing *today* or they can be randomized. In the first case, each 20-year simulation is meant to represent the *next* 20 years, starting today. In the second case, each 20-year simulation is meant to represent any 20-year period.[3] We believe the randomized start condition is the most practical option to implement, since it does not require constant updating to the starting conditions every time someone chooses to run the model. To randomize the starting conditions, it is sufficient to start with no ongoing operations and run the model for $\Delta + T$ months, where Δ is greater than or equal to the maximum

[3] A third option is to start with nothing ongoing at the start of every 20-year period—this seemed the least realistic of all the options.

possible duration of any single operation. The first Δ months are then thrown out and the $\Delta + 1^{st}$ month is treated as the beginning of each future for analysis purposes.[4]

3. Assumptions of the Demand Model

Two important assumptions underlie the stochastic demand model. First, to keep the simulation tractable, we assume that requirements are generated solely by the exogenously supplied operation characteristics. As a result, demand is not affected by past performance. For example, shortfalls in unit supply do not create additional requirements or change the likelihood or duration of any operations. Making demand dependent on force sufficiency would require us to model combat operations in a level of detail that is far outside the scope of this model. We believe the model in its current form is still useful for understanding the many complex decisions that affect force sufficiency.

Second, to keep the inputs tractable, we assume that operations begin independently. While it is likely that the initiation of an operation in one region may affect the probability of operations beginning in other regions, the direction of the correlation is not clear. For example, it is possible that responding to an act of aggression in one region acts as deterrence to potential combatants in other regions, decreasing the probability of some operation types. Alternatively, potential combatants may believe that by committing to one operation, the United States will not have sufficient resources to respond effectively elsewhere and thus may increase the probability of beginning an operation. In a practical sense, a fully specified model of interdependent operations would create a burdensome requirement for a user to fill out a $P \times P$ matrix with potentially hundreds or thousands of correlations.

To account for current planning guidance that limits the number of simultaneous major combat operations (MCOs) for which the US military can plan, we included the option of adding restrictions to the demand model that constrain the number of each type of operation that can occur simultaneously.

C. Supply Model

Since SARA Version 2.0 models Army units, the supply model is based on a rotational Army Force Generation (ARFORGEN) cycle, although it can be adjusted to simulate alternate force management postures.

4 In our example in Chapter 3, we simulate 40 years for each future and just evaluate the last 20.

1. Assumptions of the Supply Model

The assumptions of the supply model are as follows:

- **Units do not deploy to a particular operation.** Monthly requirements from the demand model are aggregated across all ongoing operations to produce a single requirement for each unit type every month. The supply model then deploys units against this total demand until all requirements are filled. Hence, the SARA model assumes that there is no additional time or cost penalty for a unit that might have effectively switched operations mid-deployment.
- **Unit types are not substitutable.** The supply model in SARA Version 2.0 runs separately for each unit type. As a result, we implicitly assume that a requirement for one type of unit cannot be filled with a different type of unit.
- **The resources exist to deploy all brigades at once.** We assume sufficient equipment and personnel exist to fill out all modeled units to full readiness. Similarly, we assume there are no training bottlenecks that limit how many units can be at any given stage of readiness. Moreover, we do not model airlift and sealift constraints, so any number of fully ready units can be deployed at the same time.
- **There are no additional costs or constraints from "casualties."** Since SARA is not a combat model per se, we do not explicitly model casualties from units that might be deployed to dangerous locations. Hence, units that have been deployed for long periods of time do not suffer loss of effectiveness from injured or stressed personnel or from damaged or deteriorating equipment. It is possible to adjust the costs of deployment in the cost model (described in more detail in section 2.D) to account for the possibility of individual replacements or equipment substitutions in later months of deployment. This adjustment would implicitly capture the additional costs of casualties, although it is an imperfect adjustment since the deployment costs are the same for all operations. In our example described in Chapter 3, we do not adjust costs for casualties.

2. Force Management Policy

The supply model takes the requirements generated by the demand model as given and rotates units through dwell and deployment periods to meet demand and a set of force management policies supplied by the user and contains two rotation policies: a "planned" rotation for when demand is relatively low and an auxiliary rotation for when the planned rotation cannot supply enough units to meet requirements.

Figure 2 shows an example of a force management policy.

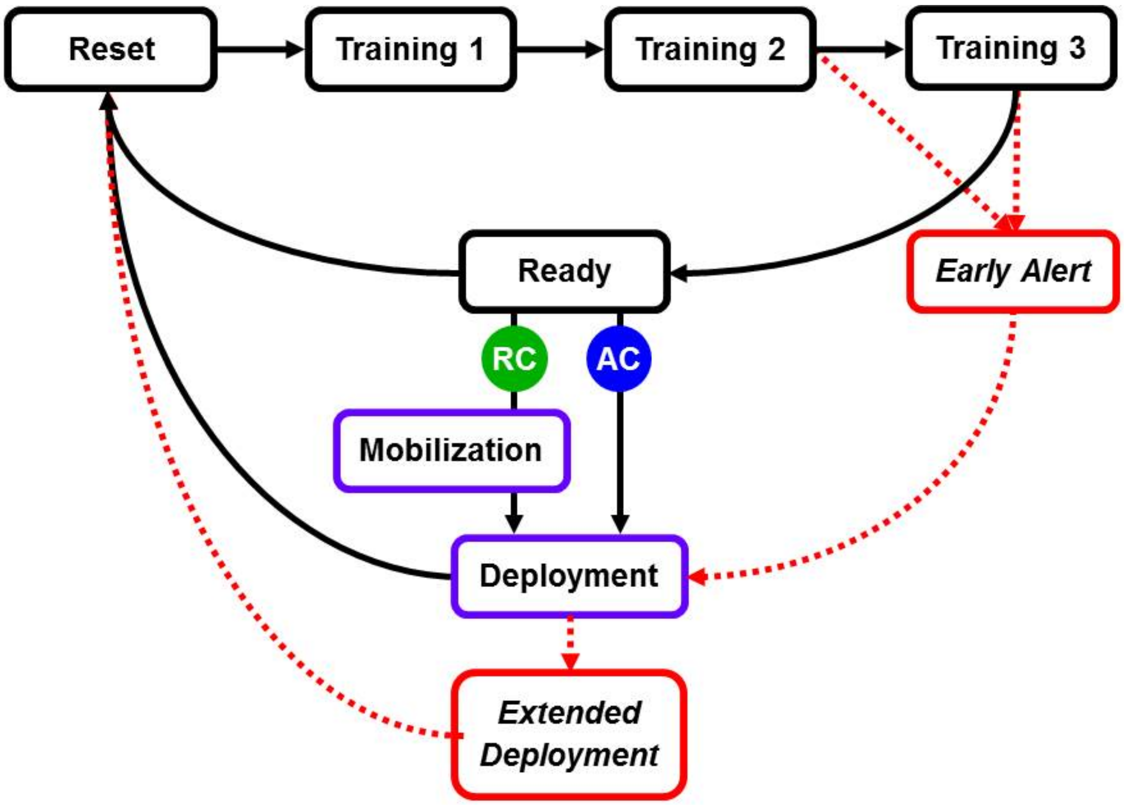

Figure 2. Force Management Rotation Policy

A force management policy for unit type j in component $k \in \{\text{AC}, \text{RC}\}$ is

$$\mathcal{M}_{jk} = \{B_{jk}, R_{jk}, \boldsymbol{d}_{jk}^{DW}, d_{jk}^{DEP}, d_{\text{jk}}^{MOB}, d_{jk}^{EXT}, \boldsymbol{d}_{rjk}^{AL}\}. \tag{2}$$

The first five terms in brackets define the planned rotation policy. The first term, B_{jk}, is the total number of units of type j in component k (hereafter referred to as jk units) in the inventory. R_{jk} is the number of readiness levels a jk unit should pass through in dwell. For example, Figure 2 shows five readiness levels: Reset, Training 1, Training 2, Training 3, and Ready. Vector $\boldsymbol{d}_{jk}^{DW} = [d_{1jk}, d_{2jk}, \dots, d_{Rjk}]$ is the number of months a jk unit is expected to spend in each readiness level r. The total planned dwell period equals the sum of these durations: $D_{jk}^{DW} = \sum_{r=1}^{R} d_{rjk}$. d_{jk}^{DEP} is the planned maximum number of months a jk unit may be deployed. For RC units, $d_{j,\text{RC}}^{MOB} \in \{0, 1, 2, \dots\}$ defines the number of months a unit of type j at readiness level R must be mobilized after activation before it can be deployed. ($d_{j,AC}^{MOB}$ is assumed to equal zero.) Hence the total planned rotation length of a jk unit is

$$D_{jk}^{PLAN} = D_{jk}^{DW} + d_{\text{jk}}^{MOB} + d_{jk}^{DEP}. \tag{3}$$

The final two terms in Equation (2) characterize the auxiliary rotation cycle. When there are otherwise insufficient units to meet demand, deployed units that are due to return to reset may be extended and training units that are not yet ready may shift to a more intensive training program, here called "early alert" to speed up their readiness. d_{jk}^{EXT} represents the maximum additional months a jk unit's deployment may be extended. ($d_{jk}^{EXT} \geq T$ corresponds to unconstrained deployments.) $\boldsymbol{d}_{rjk}^{AL}$ represents how many months a jk unit at readiness level r needs in order to reach full readiness in early alert. Not all levels of readiness may necessarily be alertable. For example, in Figure 1, only units in the readiness levels that correspond to Training 2 and Training 3 may be alerted early. Units in Reset or Training 1 must pass through the entire duration of these levels before they can be alerted.

Version 2.0 of the SARA model is an accounting model, so instead of tracking units individually, it keeps track of how many units are in each month of each stage of the rotation (e.g., how many units are in the first month of Reset, how many units are in the second month of Reset, etc.). Let $b_{jk\tau r}$ equal the number of jk units in the τ^{th} month of readiness level r (including early alert and deployment). The total number of jk units across all stages of the rotation cycle must sum to the total number of jk units in the inventory:

$$B_{jk} = \sum_{r=1}^{R_{jk}} \sum_{\tau=1}^{d_{rjk}} b_{jk\tau r} + \sum_{\tau=1}^{d_{jk}^{AL}} b_{jk\tau,AL} + \sum_{\tau=1}^{d_{jk}^{MOB}} b_{jk\tau,MOB} + \sum_{\tau=1}^{d_{jk}^{DEP}} b_{jk\tau,DEP} \sum_{\tau=1}^{d_{jk}^{XDEP}} b_{jk\tau,XDEP} \tag{4}$$

At the start of each month, all units in dwell are advanced forward in their dwell cycles by one period (e.g., units in the first month of Reset advance to the second month of Reset, and units in the last month of readiness level $r < R$ advance to the first month of training level $r + 1$). Units in the last month of readiness level R advance to the first month of readiness level 1 (Reset) unless they are needed to deploy. All deployed units return home unless they are needed to fulfill requirements. The next section describes how units are deployed. Table 2 summarizes the supply model inputs.

Table 2. Supply Model Inputs

Input	Description
B_{jk}	Number of jk units in inventory
R_{jk}	Number of planned readiness levels for jk units in dwell
$\boldsymbol{d}_{jk}^{DW}$	Vector of durations of each readiness level of jk units
d_{jk}^{DEP}	Planned duration of deployments of jk units
d_{jk}^{MOB}	Planned duration of mobilizations of jk units (equals zero for AC units)
d_{jk}^{EXT}	Maximum additional duration of extended deployments of jk units
$\boldsymbol{d}_{rjk}^{AL}$	Duration of early alert for jk units alerted at readiness level *r<R*

3. Initial Conditions

As mentioned in section 2.B.2, the SARA model randomizes the starting states by simulating $\Delta + T$ months and only evaluating the final T. In the supply model, units in the inventory are initially distributed evenly across readiness levels in dwell. The supply model is then also run for $\Delta + T$ months so that the position of units in the ARFORGEN cycle at the start of each T month future is also randomized according to whatever happened in the first Δ months of the simulation.

4. Order of Deployment

In Version 2.0 of the SARA model, the deployment policy is built-in. In each month t, the demand model creates a requirement u_{jt} for j units that can be filled by either component. The objective of the supply model is to deploy units to meet this requirement subject to the constraints of the force management policy. Let $\delta_{jk\tau t}$ be the number of jk units that have been deployed for τ months in month t, and let $\delta_{jt} = \sum_{k \in \{AC,RC\}} \sum_{\tau=1}^{d_{jk}^{DEP}+d_{jk}^{EXT}} \delta_{jk\tau t}$(5) be the total number of j units of either component deployed in month t. The SARA model fills the demand requirements by deploying j units in the following order until $\delta_{jt} = u_{jt}$ (requirements are met) or no units remain available to deploy:

1. Units that were on deployment the previous month with less than d_{jk}^{DEP} months of deployment, starting with units that have been deployed the longest. For units with equal prior deployment lengths, prioritize AC units.

2. AC units readiness level R, starting with those who have been at this readiness level the longest.

3. RC units that have completed d_{jk}^{MOB} months of mobilization.

If after Step 3, $\delta_{jt} < u_{jt}$, then the SARA model automatically switches unit j to its auxiliary cycle and continues with the following steps:

1. Units that completed at least d_{jk}^{DEP} months of deployment the previous month are extended, starting with units that have been deployed the longest. For units with equal prior deployment lengths, prioritize AC units.
2. No further units are available for immediate deployment. The SARA model now calculates a shortfall $s_{jt} = u_{jt} - \delta_{jt}$.
3. RC units at readiness level *R* are mobilized, starting with those that have been at this readiness level the longest.
4. AC units that were at an alertable readiness level are shifted into early alert training, starting with the most ready AC units.
5. RC units that were at an alertable readiness level are shifted into early alert training, starting with the most ready RC units.

The combined number of post-mobilization, pre-deployment j RC units and alerted jk units will be less than or equal to the number of shortfalls s_{jt}.

D. Cost Model

The user inputs costs in the SARA model for each possible readiness or deployment state of a jk unit. Let c_{jkr} equal the monthly cost of a jk unit at readiness level r (including alerts, mobilization, and deployment), and let $c_{jk,LIFT}$ represent the *additional* costs related to moving a unit that are incurred in the first month of a deployment. Then the full cost of an inventory of j units in any given month t of a future is

$$C_{jt} = \sum_{k\in\{AC,RC\}} \Big[\sum_{r=1}^{R_{jk}} \sum_{\tau=1}^{d_{rjk}} c_{jkr} b_{jk\tau r} + \sum_{\tau=1}^{d_{jk}^{AL}} c_{jk,AL}, b_{jk\tau,AL} + \sum_{\tau=1}^{d_{jk}^{MOB}} c_{jk,MOB} b_{jk\tau,MOB} + \left(c_{jk,LIFT} + c_{jk,DEP}\right) b_{jk1,DEP} + \sum_{\tau=2}^{d_{jk}^{DEP}} c_{jk,DEP} b_{jk\tau,DEP} + \sum_{\tau=1}^{d_{jk}^{XDEP}} c_{jk,XDEP} b_{jk\tau,XDEP}\Big]. \qquad (6)$$

Note that monthly cost depends on the number of units that are deployed each month. Hence, the SARA model accounts for *use costs* as well as maintenance costs. (Maintenance costs can be easily estimated by running the supply model against a future with no requirements.)

1. Assumptions of the Cost Model

To estimate costs in the SARA model, we assume that the monthly costs for a given readiness state are invariant to the number of units at that level of readiness and to the length of time a unit has been at that level of readiness. In addition, costs are only incurred for existing units, so there is no additional cost from an unmet demand. Rather, we treat cost and unmet demand as a tradeoff, which we visualize in an efficiency frontier (described in section 3.E).

3. A Notional Example

The SARA model is a framework to experiment with the impact of varying the inputs described in Chapter 2. In this chapter, we demonstrate some applications of the SARA model using notional data. This exercise is intended as a proof-of-concept to show how the SARA model can be applied to answer many force planning questions. Since the data is notional, we suggest that the results should be treated with caution. As mentioned in Chapter 2, we model all units in this example at the brigade level.

A. Baseline Demand Case

The true probability of future events is unknowable. However, the SARA model can assess force planning under alternative views of the future. For our proof-of-concept exercises, we model a future that is derived from historical events and their historical frequencies. While we do suggest that the future is simply a repetition of past events, we do believe that historical frequencies provide a useful baseline for comparison of more speculative possibilities.

John Brinkerhoff describes seven foreign and six domestic military operations in which the Army might be expected to participate and proposes notional requirements for these operations.[5] In our baseline runs, we simulate the seven operation types—six foreign and one domestic—that have a historical analog and require the GPF. Table 3 describes the historical analogs and the simulated frequencies of these operations. For major combat operations—theater air-sea battle campaigns (TASBCs), theater land combat campaigns (TLCCs), and counterinsurgency campaigns (COINs)—we identify the best analogs since 1950 (i.e., after World War II). The number of historical analogs is then divided by the number of months in the period of analysis to obtain the expected monthly starting frequency. For example, we identify three historical analogs for counter-insurgency campaigns (the Vietnam War, Operation Enduring Freedom (OEF), and Operation Iraqi Freedom (OIF) during the 720-month period from 1950 to 2009. Hence, the expected starting frequency of a COIN operation is $\frac{3}{720} = 0.00417$. For minor contingencies and humanitarian relief operations, we identify historical analogs in the post-Cold War period from 1991 to 2012. Brinkerhoff describes a Defense Support to Civil Authorities (DSCA) emergency arising from a natural disaster. Since the rate of

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5 John Brinkerhoff, "A Notional Army for SLIM," IDA Working Paper (Alexandria, VA: Institute for Defense Analyses, 2013).

natural disasters is unlikely to change much over time, we count the number of natural disasters affecting the United States since 1776. Finally, the US Army maintains a presence across the world, so we assume that there is a constant requirement for theater engagement in five commands. Table 4 describes the number of stages and their durations for each operation.

Table 3. Baseline Operations and Expected Frequencies

Operation	Period of Analysis	Number of Observed Operations	Historical Analogs	Monthly Frequency
Theater Air-Sea Battle Campaign	1950–2009	2	Taiwan mobilization during the Korean war, Cuban missile crisis	0.00278
Theater Land Combat Campaign	1950–2009	2	Korea, Gulf War I	0.00278
Counter-Insurgency Campaign	1950–2009	3	Vietnam, Afghanistan, Iraq	0.00417
Minor Contingency	1991–2012	4	Somalia (Restore Hope/Continue Hope) (1992–93), Uphold Democracy (Haiti 1994–95), Infinite Reach (Sudan/Afghanistan 1998), Operation Stabilize (East Timor 1999)	0.0152
Humanitarian Relief	1991–2012	2	Strong Support (Fuerte Apoyo) (HA/DR Hurricane Mitch 1998), Unified Assistance (Tsunami Relief 2005)	0.00758
DSCA: Major Emergency	1776–2012	85	Hurricanes, tornados, blizzards, wildfires, firestorms, severe heat and cold waves, earthquakes, tsunamis, avalanches, floods, and volcanic eruptions	0.0299
Theater Engagement (Five Commands)	Always ongoing. Occurs each month with certainty.			

Table 4. Duration of Operations

Operation	Stages	Duration
Theater Air-Sea Battle Campaign	1	5 months
	2	35 months
Theater Land Combat Campaign	1	4 months
	1	53 months
Counter-Insurgency Campaign	1	4 months
	2	8–14 years
Minor Contingency	1	3 months
Humanitarian Relief	1	2 months
DSCA: Major Emergency	1	1 month
Theater Engagement (Five Commands)	1	Ongoing

Table 5. Notional Troop Lists

Army Organizations	Domestic Major Emergency	Theater Engagement	Humanitarian Relief	Minor Contingency	COIN Campaign		Theater Air-Sea Battle Campaign		Theater Land Combat Campaign	
					Stage 1	Stage 2	Stage 1	Stage 2	Stage 1	Stage 2
Corps HQ					2	1			2	1
Division HQ	1		1	1	6	3	1	1	6	3
Brigade Combat Team		5		2	18	9	4	1	18	9
Combat Aviation Brigade				1	6	2			6	3
Fires Brigade				2	6	1	1	1	6	3
Battlefield Surveillance Brigade				1	2	2			2	1
Maneuver Enhancement Brigade	2		1	2	6	3	3	1	6	3
Sustainment Brigade	2		1	2	10	4	3	1	10	5
Civil Affairs Brigade					2	2			2	1
MISO Group					1	1			1	1
Air Defense Brigade					2		4	1	2	1
Theater Aviation Brigade	1		1	1	2		3	1	2	1
Engineer Brigade	1			1	4	3	1	1	4	2
Military Intelligence Brigade					2	2	1	1	2	1
Military Police Brigade	2				2	2			2	1
Chemical Brigade					1				1	1
Tactical Signal Brigade					2	1	1	1	2	1
Medical Brigade					2	2			2	1

In addition to specifying notional operations, Brinkerhoff also defines the composition of 18 notional brigades at the Standard Requirements Code (SRC) level and provides requirements for these brigades for each operation type.[6] While Brinkerhoff's operations are based largely on operations in which the Army has participated in the past, the specified brigade requirements are based on a current understanding of how Army brigades would likely be used in a future event. Table 5 lists the notional troop requirements for each operation. The 18 brigades types include two headquarters, two combat brigades, four modular brigades, and ten functional brigades.

Using the inputs provided in Table 3 through Table 5, we simulate 10,000 independent 20-year futures[7] for a total of 2.4 million simulated months. Figure 3 shows two draws from the demand simulation: one example with near-median cumulative demand (summed across all unit types and all months) and one with the highest cumulative demand of all 10,000 simulations. Each chart shows the sum of the requirements for all 18 brigades types (a rough proxy for the size of an operation) across time. As Figure 3 shows, the primary driver of demand requirements are the major combat operations, particularly the land operations.[8] The median case shows a level of activity that is not atypical for historical US Army engagement. The highest-demand case is naturally quite extreme (up to six simultaneous MCOs) since it represents the worst of ten thousand draws.

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[6] Brinkerhoff, "A Notional Army for SLIM."

[7] More specifically, we simulate 40-year futures, but only analyze the last 20 years.

[8] TASBCs are not as large because the Army does not have as large a presence as the Navy and Air Force would have.

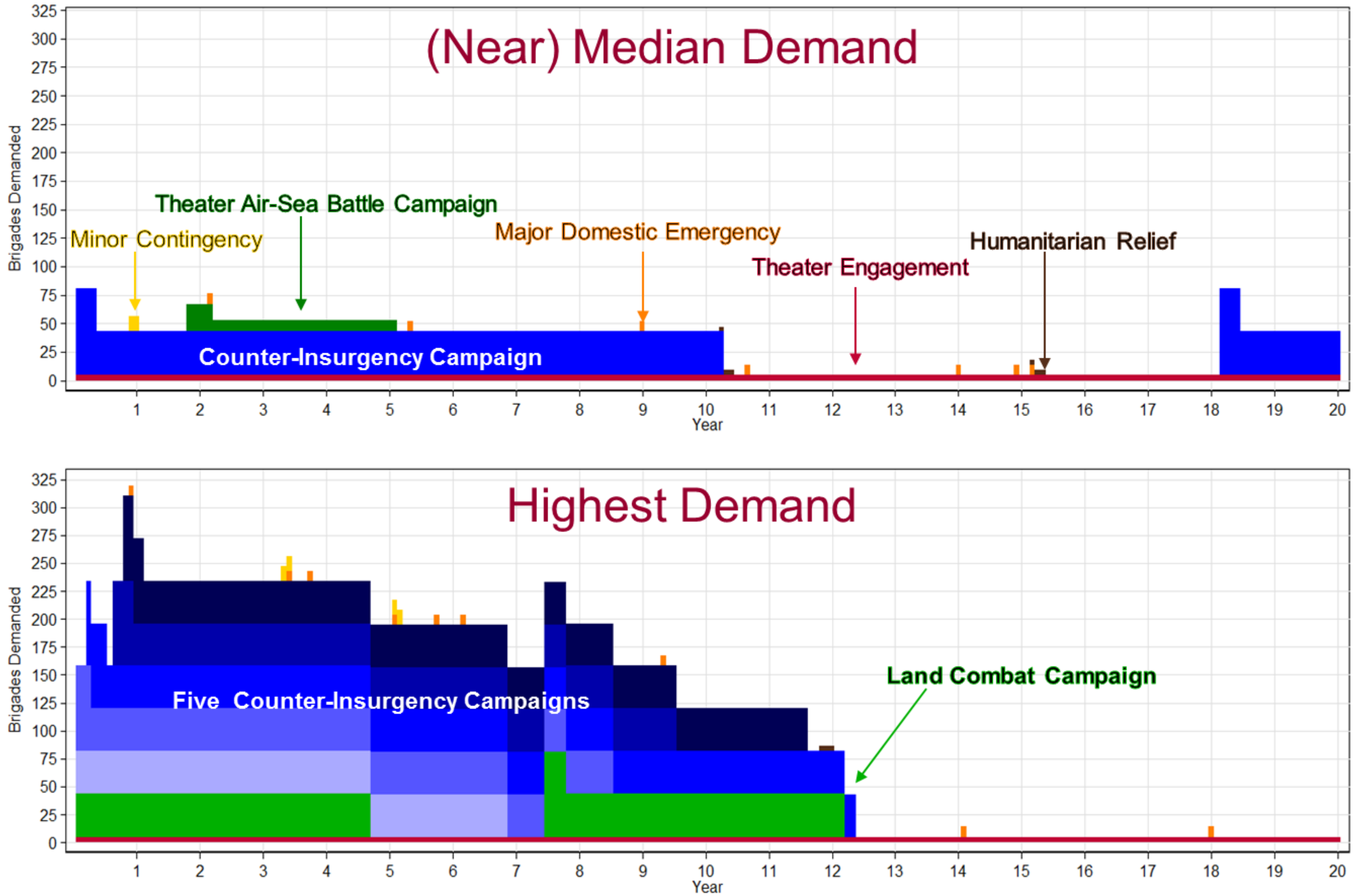

Figure 3. Two Demand Output Examples

B. Baseline Supply Rules

Brinkerhoff describes a notional Army inventory based on the Army headquarters inventory in the Fiscal Year (FY)14 Future Years Defense Program (FYDP).[9] This notional Army comprises combat brigades, headquarters, modular brigades, and functional brigades. We combined the three BCT types (Infantry, Stryker, and Armored) into one standardized BCT type with three maneuver battalions each, since these BCTs are often substitutable for one another. Table 6 displays this inventory for our 18 brigade types.

Table 6. Notional Army Inventory

Army Notional Brigades	AC Inventory	RC Inventory
Combat Brigades		
Brigade Combat Team	32	28
Combat Aviation Brigade	10	8
Headquarters		
Corps Headquarters	4	0
Division Headquarters	10	8
Modular Brigades		
Battlefield Surveillance Brigade	3	7
Maneuver Enhancement Brigade	2	19
Fires Brigade	7	7
Sustainment Brigade	13	19
Functional Brigades		
Air Defense Brigade	5	2
Theater Aviation Brigade	0	6
Military Intelligence Brigade	5	0
Civil Affairs Brigade	1	9
Military Information Support Ops Group	0	2
Engineer Brigade	6	11
Military Police Brigade	5	7
Chemical Brigade	1	2
Signal Brigade	4	4
Medical Brigade	4	10

9 Brinkerhoff, “A Notional Army for SLIM.”

Table 7 displays the supply rules we model for all Active and Reserve units. These rotation rules are modeled on the ARFORGEN policy and correspond to a 1:2.67 BoG-to-dwell ratio for the AC and a 1:4 MOB-to-dwell ratio for the RC.

Table 7. Baseline Supply Rules

Readiness Level	AC Maximum Duration	RC Maximum Duration
Reset	6 months	12 months
Training 1	0 months	12 months
Training 2	6 months	12 months
Training 3	12 months	12 months
Ready	12 months	12 months
Mobilization	0 months	3 months
Deployment (Planned)	9 months	9 months
Early Alert	9 months	9 months
Extended Deployment	6 months	6 months

These supply rules best reflect the alert speeds of BCTs. The time to ready for other units may be faster, and the required mobilization periods of RC units may be shorter. While the SARA model permits variation of the supply rules by unit type, we are lacking information about the training rates of other unit types. Hence, for the purposes of demonstration, we apply these supply rules to all brigade types and focus most of our example results on BCTs.

C. Baseline Costs

The cost inputs in our baseline case are derived from the Active-Reserve Force Cost Model (ARFCM) described in McGee et al.,[10] based on the supply rules provided in the previous section. These costs include personnel, operations, infrastructure (including base operations, recruiting, initial skill training, and medical) and deployment. The ARFCM derives its costs from the Force and Organization Cost Estimating System (FORCES) Cost Model, the Army Military-Civilian Cost System (AMCOS), and the IDA Contingency Operations Model.

Brinkerhoff defines the composition of 20 notional brigade types at the SRC level.[11] We cost each of these SRCs in the ARFCM at each of the readiness levels in the SARA model. The costs of the notional brigades are then the sum of the costs of the component SRCs. The monthly costs for an AC and an RC brigade combat team are shown in

[10] Shaun K. McGee, Lance M. Roark, Laila A. Wahedi, and Stanley A. Horowitz. “Active-Reserve Cost Model.” IDA Document D-5057, Alexandria, VA: Institute for Defense Analyses, 2015.

[11] Brinkerhoff, “A Notional Army for SLIM.”

Table 8. Table A-1 in Appendix A provides the estimated monthly costs for all of the brigade types we model.

Table 8. Monthly Costs of Brigade Combat Teams

Unit Position	Active Component	Reserve Component
Reset	41.9	13.3
Training 1		15.1
Training 2	47.4	16.9
Training 3	48.6	21.5
Ready	50.1	15.9
Deployment	66.5	62.3
Deployment Initiation	240.7	253.8

Note: Monthly costs of extended deployment cost and pre-deployment mobilization costs (for RC brigades) are assumed to equal monthly deployment costs. Deployment initiation costs are added to monthly deployment costs the first month of a deployment (AC) or mobilization (RC).

D. Baseline Output

On any given run, the SARA model produces a vast amount of data. For each month of each of the 10,000 simulated 20-year futures, the SARA model produces

- the number of ongoing operations and their stages;
- the cumulative requirements for each unit type across all the ongoing operations;
- the number of units in each month of each readiness level by unit type and component;
- the number of deployed units of each type and component (and how long they have been deployed);
- the monthly cost of each unit type based on the current rotation posture of the AC and RC units; and
- the number of requirements for each unit type that are unmet.

A lot of information can be gleaned from exploring this output and comparing it to new runs with different inputs. In this section, we show some of the output from the SARA model using the inputs described in the previous sections. ***However, since these inputs are largely notional, it is important to remember that the results in the following sections are merely suggestive*** and are primarily intended to show the utility of this framework for assisting force planners.

Figure 4 shows the demand and deployments for BCTs in the same two futures described by Figure 3. In a moderate case, the BCT inventory and supply rules are sufficient to meet demand in most cases. The AC provides the bulk of the supply with the RC relieving the active BCTs most notably midway through Year 1 and Year 12, although as Figure 5 shows, there is still a heavy reliance on extended deployments. For the first nine years of the highest demand case, BCTs are training as fast as possible and deploying for as long as possible. This extreme case highlights the most output that a given inventory of BCTs can provide with the given supply rules.

It is also possible to use the SARA model to look at comparisons across brigade types. Figure 6 and Figure 7 show four of the possible comparisons. Figure 6 shows two ways of comparing force sufficiency across brigade types: Panel A shows a comparison of the expected level of unmet demand in the worst 10 percent of the 2.4 million months SARA simulates, and Panel B shows the expected percent of demand that is unmet in those same months. Figure 7 displays the percent of futures with average Active (Panel A) and Reserve (Panel B) rotation rates[12] faster than the inputted policy (0.75:2 for Actives and 1:4 for Reserves). These figures show, for example, that according to our supply rules,[13] Military Information Support Operations (MISO) groups and Maneuver Enhancement Brigades (MEBs) are the two unit types with the most risk: unmet demand is high in both absolute and percentage terms and both brigade types have a 20-year average rotation rate faster than policy in a large percentage of simulated futures. This observation does not necessarily mean that additional MISO groups and MEBs should be added to the inventory (especially given the BCT-based supply rules), because the opportunity cost of expanding these capabilities depends on the constraints facing Force planners and could include reducing capabilities in other more critical areas. Using these charts, Force planners can evaluate the risks being taken across various unit types and rebalance according to the most critical capabilities.

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[12] Average rotation rates are calculated as the sum of all mobilized brigade months divided by the sum of all non-mobilized brigade months for each brigade type in each 20-year future.

[13] As we mentioned in Section 3.B, the supply rules in this simulation are most applicable for BCTs. As a result, the output for the non-BCT brigade types in Figure 6 and Figure 7 should be viewed with caution.

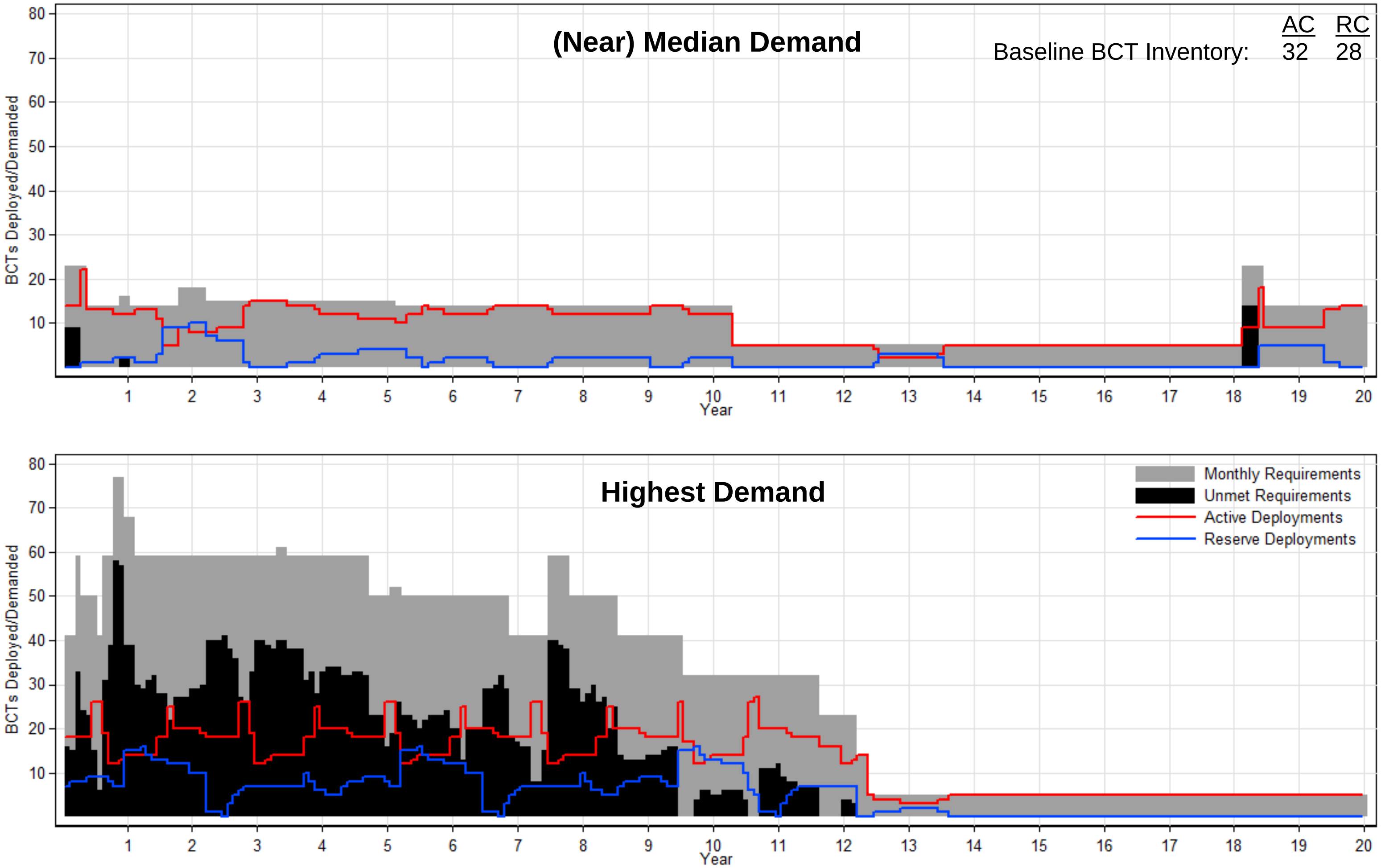


Figure 4. BCT Demands and Deployments in Two Representative Futures

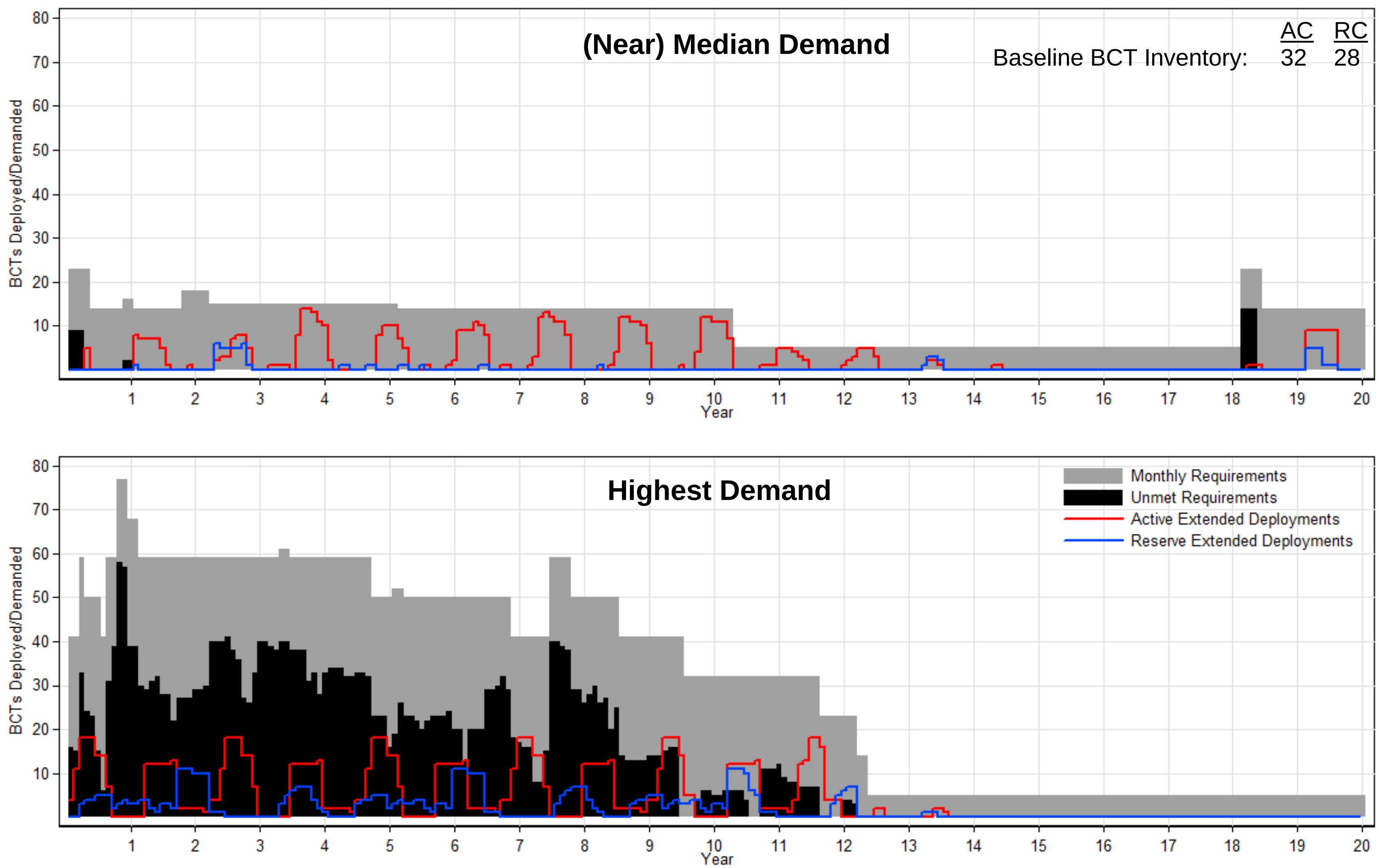
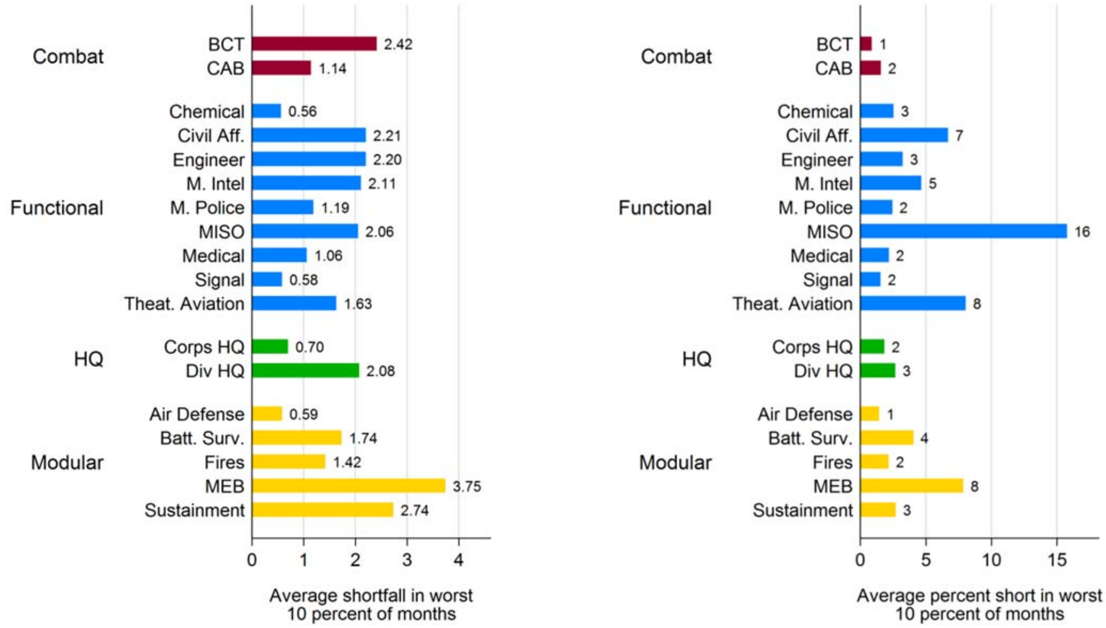


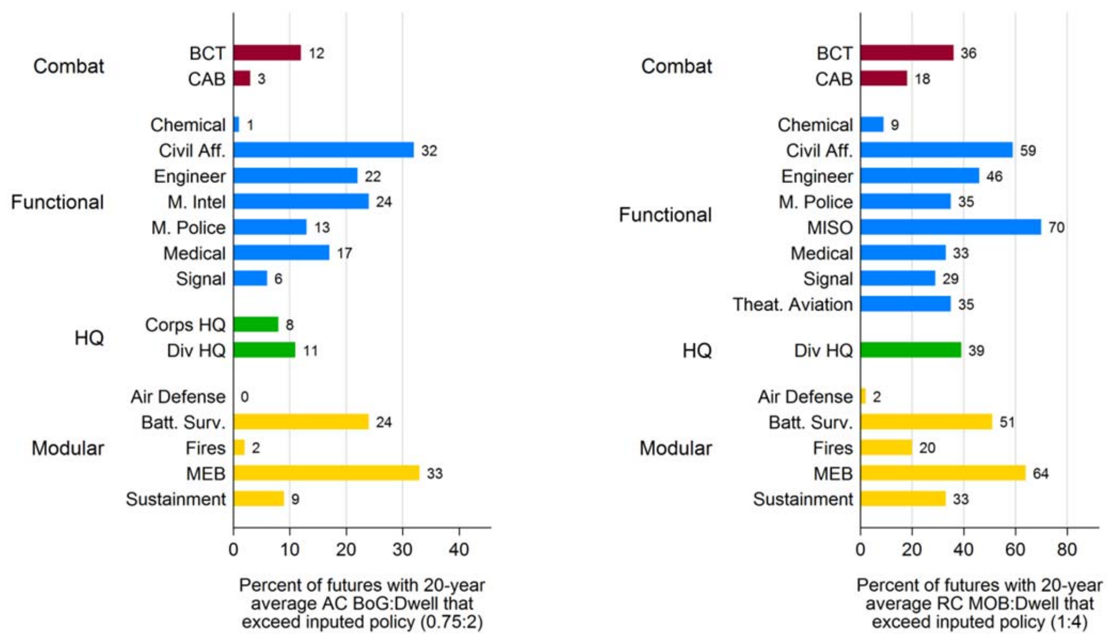
Figure 5. BCT Demands and *Extended* Deployments in Two Representative Futures



Panel A. Expected Level of Unmet Demand in the Worst 10% of Months

Panel B. Expected Percent of Unmet Demand in the Worst 10% of Months

Figure 6. Unmet Demand by Brigade Type



Panel A. AC BoG:Dwell

Panel B. RC MOB:Dwell

Figure 7. Percent of Simulated Futures with 20-year Average Rotation Rate Faster than Planned Rate

E. Comparative Statics

The previous section examined some example output from a single run of the SARA model. In this section, we show how the SARA model can be used to conduct excursions exploring the impact of changing various inputs.

1. Active-Reserve Assessment and the Efficient Frontier

To explore alternative Active and Reserve force mixes, we run the SARA model thousands of times for many potential Active-Reserve BCT mixes against the same set of 10,000 futures. Conceptually, if each mix is assigned a single value representing cost and a single value representing risk, these mixes can be plotted in cost-risk space. The lower bond of these units would then represent the *efficient frontier*, those mixes for which risk cannot be improved without raising cost and likewise cost cannot be improved without raising risk.

There are many possible cost and risk metrics. In our example below, to represent cost we calculate the average annual cost of each BCT mix across all 10,000 futures (in other words, the expected cost of a particular mix). Since the military can be thought of as a method of insuring ourselves against catastrophic threats to national security, we use a risk measure that focuses on the most stressing months: the average unmet demand in the worst 10 percent of months.[14] Figure 8 shows the how BCT shortfalls are distributed across the 2.4 million simulated months for the baseline BCT inventory (32 AC BCTs and 28 RC BCTs). There is no unmet demand in about 95 percent of months. (Arguably, given the requirement for five BCTs in all months for theater engagements, meaningful shortfalls do not appear in about 98 percent of months.) Our risk metric excludes the bottom 90 percent of months and calculates the average unmet demand in the top 10 percent shown in the blue region of Figure 8.

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[14] This metric is based on a commonly-used measure of risk in the finance literature called average value at risk (AVAR).

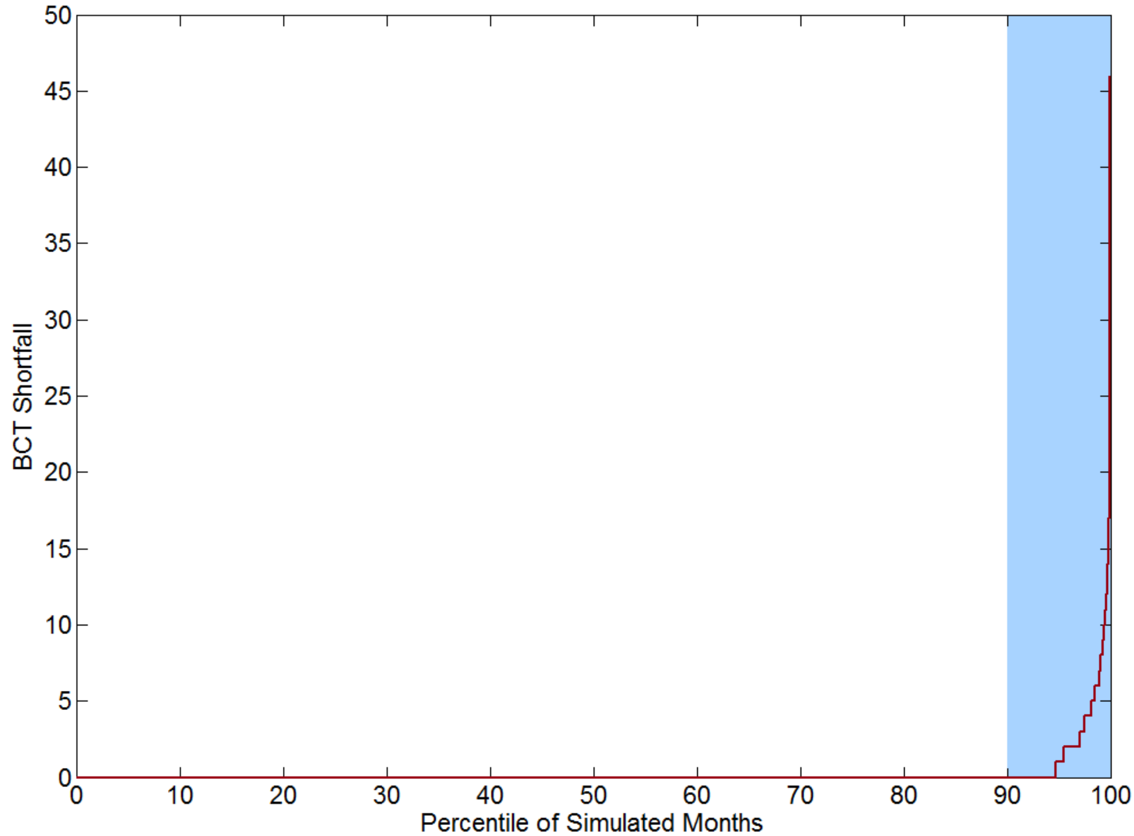

Figure 8. Distribution of BCT Shortfalls across 2.4 Million Simulated Months

We calculate a risk metric for each of several thousand BCT mixes run against the same 10,000 futures using the same supply rules.[15] In Figure 9, we plot every AC-RC BCT mix that costs less than $35 billion: each red dot represents a single BCT mix. Figure 9 also shows a few representative mixes, including the baseline mix. The blue line traces the efficient frontier—that is, the set of mixes for which no improvement can be made to cost without increasing risk and vice versa. (For example, the upper left end of the plot shows the extreme case of zero AC and zero RC BCTs. In this case, costs are zero, but all demand is unmet. This mix is efficient because the only way to improve risk is to buy a BCT, which increases cost.) The red dots represent all mixes for which another mix exists that improves on both risk *and* cost.

[15] Although we do not show it here, the supply model can also be easily run for one or a few demand scenarios of interest (bypassing the stochastic demand model) and/or for a small set of mixes that might be under consideration by Force planners.

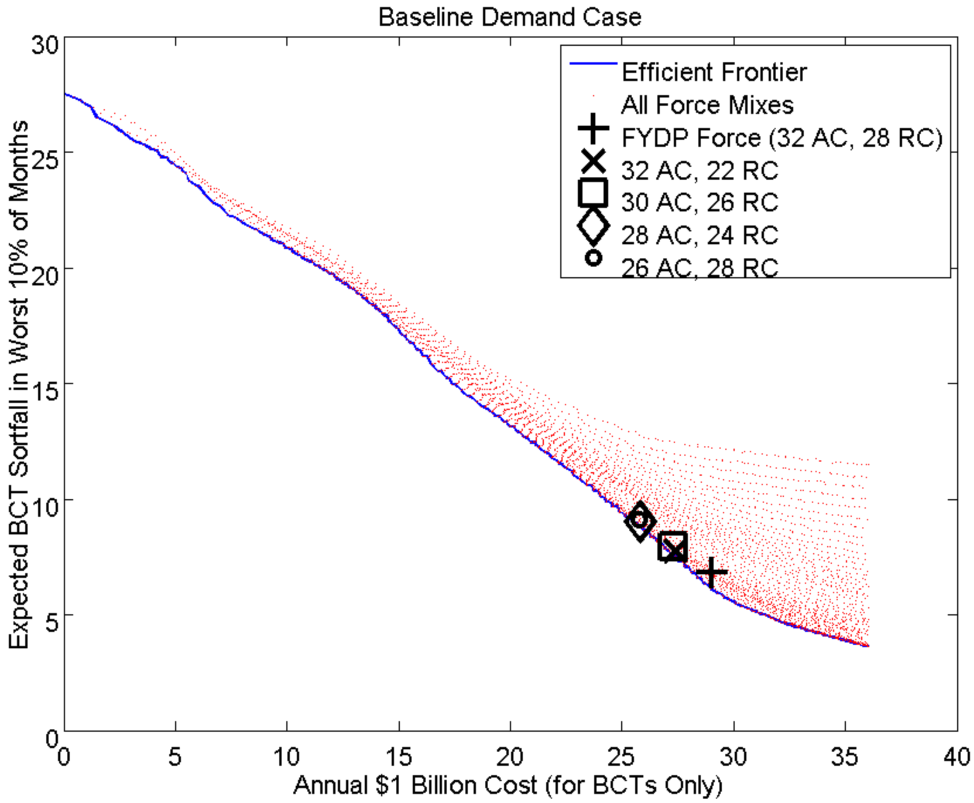

Figure 9. BCT Efficient Frontier in Baseline Case

Figure 9 shows that in the case of BCTs, a large percentage of BCT mixes are very close to the efficient frontier. This should be a reassuring finding for Force planners. Figure 9 also shows that to move from, for example, the baseline mix to 28 AC BCTs and 24 RC BCTs, the Army would save about $3 billion on average, but at a penalty of about two additional BCT shortfalls in the worst 10 percent of months.

In Figure 10, we show how the RC proportion of the BCT mixes varies across cost-risk space. In this case, we find the efficient frontier is mostly composed of AC-intensive mixes (in blue), but there are still some RC-intensive mixes very close to the efficient frontier. The general preference for AC-intensive mixes in Figure 10 is attributable in part to the risk measure that only considers the worst 10 percent of months and the supply rules that require all RC BCTs to complete three months of pre-deployment mobilization. Relaxing either of these restrictions would probably improve the results of RC-intensive mixes.

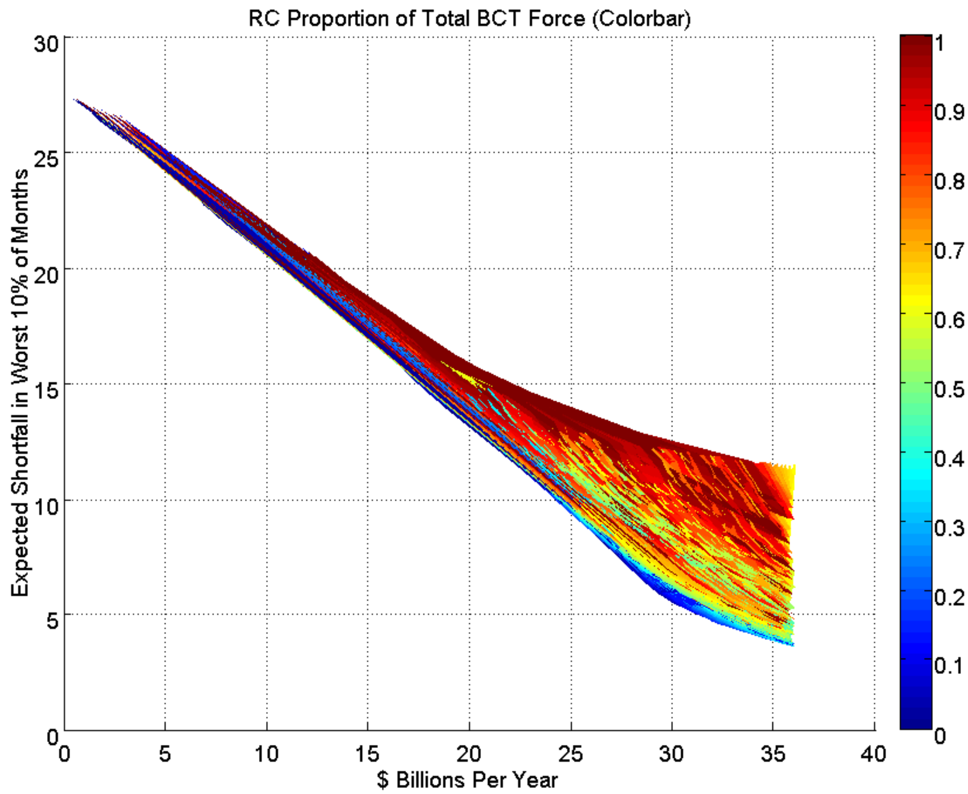

Figure 10. BCT Efficient Frontier in Baseline Case: RC Proportion

2. Varying Supply Rules

The SARA model also allows Force planners to explore the implications of alternative force management policies. For example, we ran the SARA model for all the BCT mixes plotted in Figure 9, but with the RC treated as a "strategic reserve": instead of rotating through an ARFORGEN cycle as described in Table 7, RC BCTs will now proceed from a deployment to a 12-month Reset (as before) and then directly to a T-3 level of readiness (corresponding to Training 2 in Table 7), where they will remain indefinitely until needed. Demand is primarily met by AC BCTs, and RC BCTs—when needed—are summoned out of Training 2 and sent to early alert before deploying. Figure 11 shows the efficient frontier from this new force management policy plotted against the baseline frontier from Figure 10. Using a strategic reserve, our notional BCT inventory costs less and is better able to meet demand. This improvement likely arises for two reasons. First, RC BCTs are no longer going through a costly upgrade to Training 3 and Ready (the high readiness levels) without being used. Second, because RC BCTs only go to Reset following a return from a deployment, they are much more likely to be available for early alert in periods of high demand.[16]

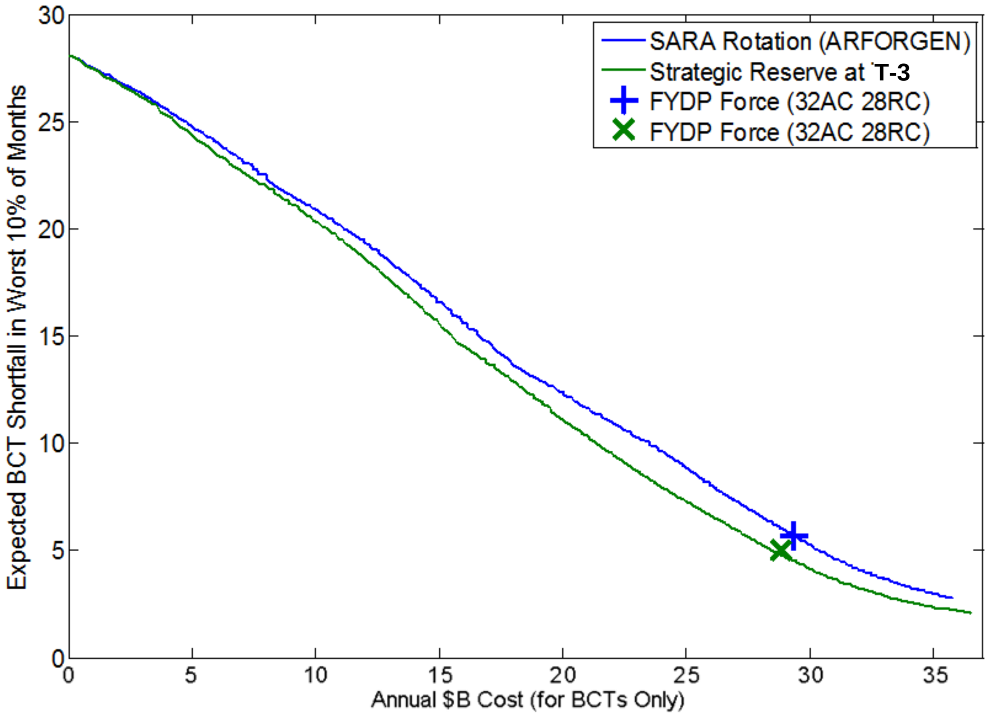

Figure 11. Alternative Force Management Policy: "Strategic" BCT Reserve

3. Varying Demand Possibilities

In all of the above examples, we have assumed that demand is generated by a set of historically based operations. In Figure 12, we show how the efficient frontier changes when the inputs to the demand model are adjusted (using the baseline supply rules). First, since DoD's current planning policy is to assume the number of simultaneous MCOs is restricted, we run a restricted demand model in which at most one land MCO (TLCC or COIN Campaign) may be fought at a time with up to one more TASBC (i.e., the worst possible case is a defeat-deny scenario). Any simulated futures that violate these constraints are thrown out and a new draw is taken until all 10,000 futures have been successfully simulated.

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16 Because of a data error, the cost of active units was understated in the calculations behind Figure 11 and Figure 12, leading the curves to be lower than they should be. This should not affect the major point of the discussion—that the changes in policy would lead the frontiers to shift down.

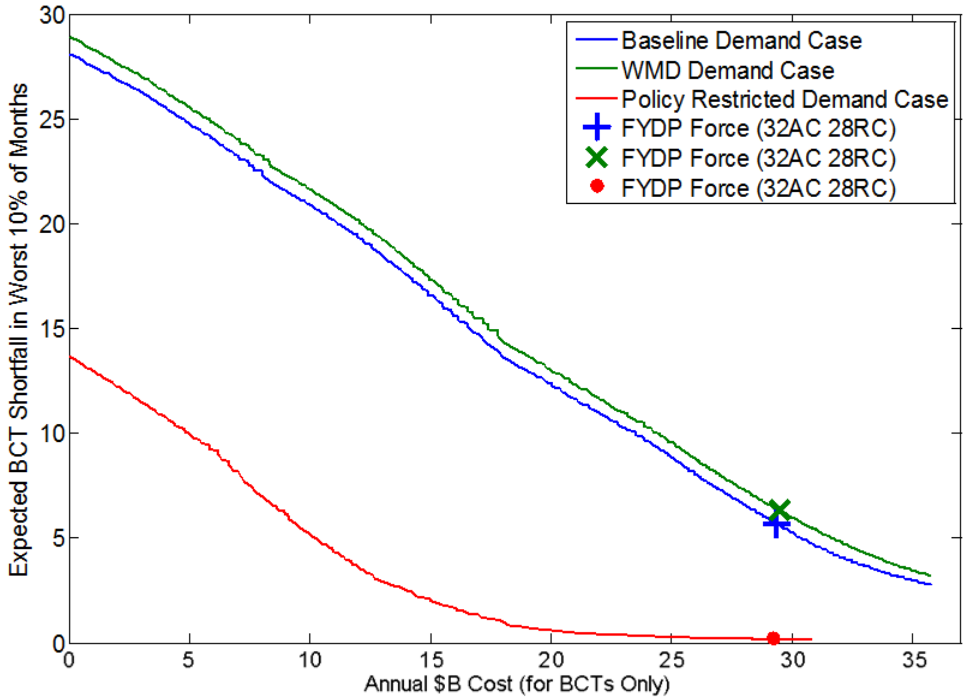

Figure 12. Alternative Demand Cases

The red line in Figure 12 outlines the efficient frontier for BCTs in this policy-restricted case. Compared to the baseline (shown in blue), average annual costs do not fall very far (compare the baseline force under the two cases) because the majority of simulations in the baseline meet the constraints of the policy-restricted case. However, the expected risk in the worst 10 percent of months falls dramatically precisely because the demand in these months has been significantly constrained. From Figure 12, Force planners can learn the consequences about their planning for the future. If they are correct, it is possible to cut the size of the force dramatically without compromising risk very much even in the most stressing cases. However, if these assumptions are incorrect, as the vertical distance between the red and blue lines shows, the consequences of cutting force structure could be quite large.

In the second demand excursion, we experimented with adding a new operation that does not yet have a historical precedent. For this excursion, we introduced a possibility of a nuclear strike on a US city corresponding to Brinkerhoff's DSCA Catastrophic Emergency.[17] Table 9 lists the requirements for a catastrophic emergency, which we assume will require 16 months of support from DoD. In this excursion, we assume nuclear attack on a single US city is expected to occur once every 20 years (i.e., the monthly probability is 0.004167), and, independently, a simultaneous nuclear attack on

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[17] Brinkerhoff, "A Notional Army for SLIM."

five US cities is expected to occur once every 100 years (i.e., the monthly probability is 0.000833).

Table 9. Brigade Requirements for DSCA Catastrophic Emergency

Army Organizations	Requirements
Corps HQ	1
Division HQ	3
Brigade Combat Team	3
Combat Aviation Brigade	0
Fires Brigade	0
Battlefield Surveillance Brigade	0
Maneuver Enhancement Brigade	3
Sustainment Brigade	4
Civil Affairs Brigade	0
MISO Group	0
Air Defense Brigade	0
Theater Aviation Brigade	3
Engineer Brigade	3
Military Intelligence Brigade	0
Military Police Brigade	3
Chemical Brigade	3
Tactical Signal Brigade	3
Medical Brigade	3

The green line in Figure 12 traces out the efficient frontier for BCTs in this more dangerous case. Compared to the baseline, both risks and costs increase, but not very much, because the new operations are still very low probability events. In this case, the implication of failing to plan for a low probability "black swan" event like a nuclear attack is minimal. (The difference in projected risks depends a lot on the choice of risk metric. For example, the risk difference between the baseline case and the black swan case would increase if we showed the expected unmet demand in the worst *1* percent of months instead.)

4. Conclusion

Building an Army for the future requires an understanding of the complex interactions of many policies that affect total force mix. The SARA model is a rich model that allows extensive exploration into these policies. In the previous section, we described just a couple of the possible policy levers with which users can experiment. Many other potential levers include, but are not limited to, varying the training requirements across a given dwell period, modifying the BoG:Dwell and MOB:Dwell ratios of Active and Reserve units, varying the limits on extended deployments, and varying the expected frequencies and durations of operations. In short, the SARA model provides a way to evaluate a wide range of defense postures in an era of vast uncertainty about what US military forces will be called on to do.

Appendix A.
Monthly Costs of Notional Brigades

Table A-1. Monthly Costs of Notional Brigades by Component and Readiness Levels ($FY11, millions)

Brigade	Component	Reset	Training 1	Training 2	Training 3	Ready	Deployment	Deployment Initiation
Corps HQ	AC	10.1		11.3	11.6	11.9	15.4	38.9
	RC	2.8	3.2	3.5	4.7	3.3	15.0	42.7
Division HQ	AC	11.5		12.9	13.2	13.5	16.5	21.5
	RC	2.9	3.2	3.5	4.6	3.2	15.4	25.2
Brigade Combat Team	AC	41.9		47.4	48.6	50.1	66.5	240.7
	RC	13.3	15.1	16.9	21.5	15.9	62.3	253.8
Combat Aviation Brigade	AC	34.9		41.1	42.6	44.1	67.3	849.6
	RC	15.3	17.6	20.7	24.0	20.0	60.9	859.7
Fires Brigade	AC	17.4		19.8	20.3	20.9	28.3	97.3
	RC	5.7	6.5	7.3	9.1	6.9	26.7	103.1
Battlefield Surveillance Brigade	AC	16.1		18.2	18.6	19.2	21.8	53.1
	RC	4.8	5.4	6.0	7.8	5.6	23.9	62.3
Maneuver Enhancement Brigade	AC	23.3		24.9	26.4	27.5	34.8	84.5
	RC	6.3	7.0	7.7	10.3	7.2	16.5	87.8
Sustainment Brigade	AC	45.9		48.9	51.8	54.1	67.9	144.2
	RC	11.8	13.2	14.5	19.4	13.5	64.2	159.5

Brigade	Component	Reset	Training 1	Training 2	Training 3	Ready	Deployment	Deployment Initiation
Civil Affairs Brigade	AC	11.4		12.2	12.9	13.4	16.6	33.8
	RC	2.9	3.3	3.6	4.8	3.3	15.8	37.5
Military Information Support Operations Group	AC	28.7		30.6	32.4	33.8	41.8	76.2
	RC	7.6	8.5	9.3	12.0	8.7	38.8	85.1
Air Defense Brigade	AC	13.7		15.0	16.0	16.5	22.3	61.8
	RC	4.4	5.0	5.7	7.2	5.4	21.4	66.6
Theater Aviation Brigade	AC	27.8		33.0	34.4	35.6	56.3	740.9
	RC	12.9	14.9	17.4	19.8	16.9	50.6	746.0
Engineer Brigade	AC	22.8		24.9	26.6	27.5	36.5	143.3
	RC	7.7	8.8	9.8	12.3	9.3	35.2	151.1
Military Intelligence Brigade	AC	14.7		15.6	16.5	17.2	21.4	32.7
	RC	3.8	4.3	4.7	6.3	4.3	21.0	38.0
Military Police Brigade	AC	17.1		18.4	19.6	20.3	26.9	100.5
	RC	5.0	5.6	6.3	8.4	5.9	25.8	107.1
Chemical Brigade	AC	13.0		13.9	14.7	15.3	19.7	72.2
	RC	3.7	4.2	4.6	6.2	4.3	19.2	77.1
Tactical Signal Brigade	AC	19.1		20.6	22.0	22.8	31.0	78.6
	RC	5.7	6.5	7.2	9.5	6.8	29.4	85.7
Medical Brigade	AC	24.5		26.1	27.6	28.8	36.3	98.4
	RC	6.8	7.6	8.4	11.2	7.9	36.2	107.2

Note: Monthly costs of extended deployment cost and pre-deployment mobilization costs (for RC brigades) are assumed to equal monthly deployment costs. Deployment initiation costs are added to monthly deployment costs the first month of a deployment (AC) or mobilization (RC).

Illustrations

Figures

Tables

References

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McGee, Shaun K., Lance M. Roark, Laila A. Wahedi, and Stanley A. Horowitz. “Active-Reserve Cost Model.” IDA Document D-5057. Alexandria, VA: Institute for Defense Analyses, 2015.

Abbreviations

AC	Active Component
AMCOS	Army Military-Civilian Cost System
ARFCM	Active-Reserve Force Cost Model
ARFORGEN	Army Force Generation
AVAR	Average Value at Risk
BCT	Brigade Combat Team
BoG	Boots on Ground
CAB	Combat Aviation Brigade
CAPE	Cost Assessment and Program Evaluation
COIN	Counter-Insurgency Campaign
DoD	Department of Defense
DSCA	Defense Support to Civil Authorities
FORCES	Force and Organization Cost Estimating System
FY	Fiscal Year
FYDP	Future Years Defense Program
GPF	General Purpose Force
IDA	Institute for Defense Analyses
MCO	Major Combat Operation
MEB	Maneuver Enhancement Brigade
MISO	Military Information Support Operations
MOB	Mobilization
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OSD	Office of the Secretary of Defense
RC	Reserve Component
SARA	Stochastic Active-Reserve Assessment
SRC	Standard Requirements Code
TASBC	Theater Air-Sea Battle Campaign
TLCC	Theater Land Combat Campaign

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

We model the demand for force structure as a function of the probability of different kinds of operational activity taking place in a given month. A range of operations is postulated and a notional force requirement is specified for every kind of operation. The Army's force generating process is modeled in a flexible fashion and the ability of various force structures to meet demand is estimated. Each of these force structures is conceptually associated with a particular operating cost and recruiting requirement. The effectiveness of the particular force structure is measured by the extent to which it meets operational requirements. Because of the probabilistic nature of future operational activity, we simulate 10,000 possible futures. This permits us to estimate the distribution of operational shortfalls and, thus, the risk associated with alternative force structures. We also estimate the cost of each force structure. This allows us to characterize every force structure in risk-cost space for a given set of operational probabilities and to identify the force structures on the efficient frontier—those alternatives for which there is no way to reduce risk without increasing costs or to reduce costs without increasing risk. Finally, by comparing efficient frontiers associated with different assumptions about operational probabilities, we illuminate how the force size and cost associated with a given level of risk depends on expectations concerning the nature of future requirements.

15. SUBJECT TERMS

Force Structure, Force Planning, AC-RC Mix, Force Structure Analysis, Force Management, Modeling, Analysis

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