Special Feature

A historical review of US wars is replete with examples of a logistics system very capable of delivering strategic resources, but often failing in getting those resources from the port of debarkation to the actual point of consumption in a timely manner.

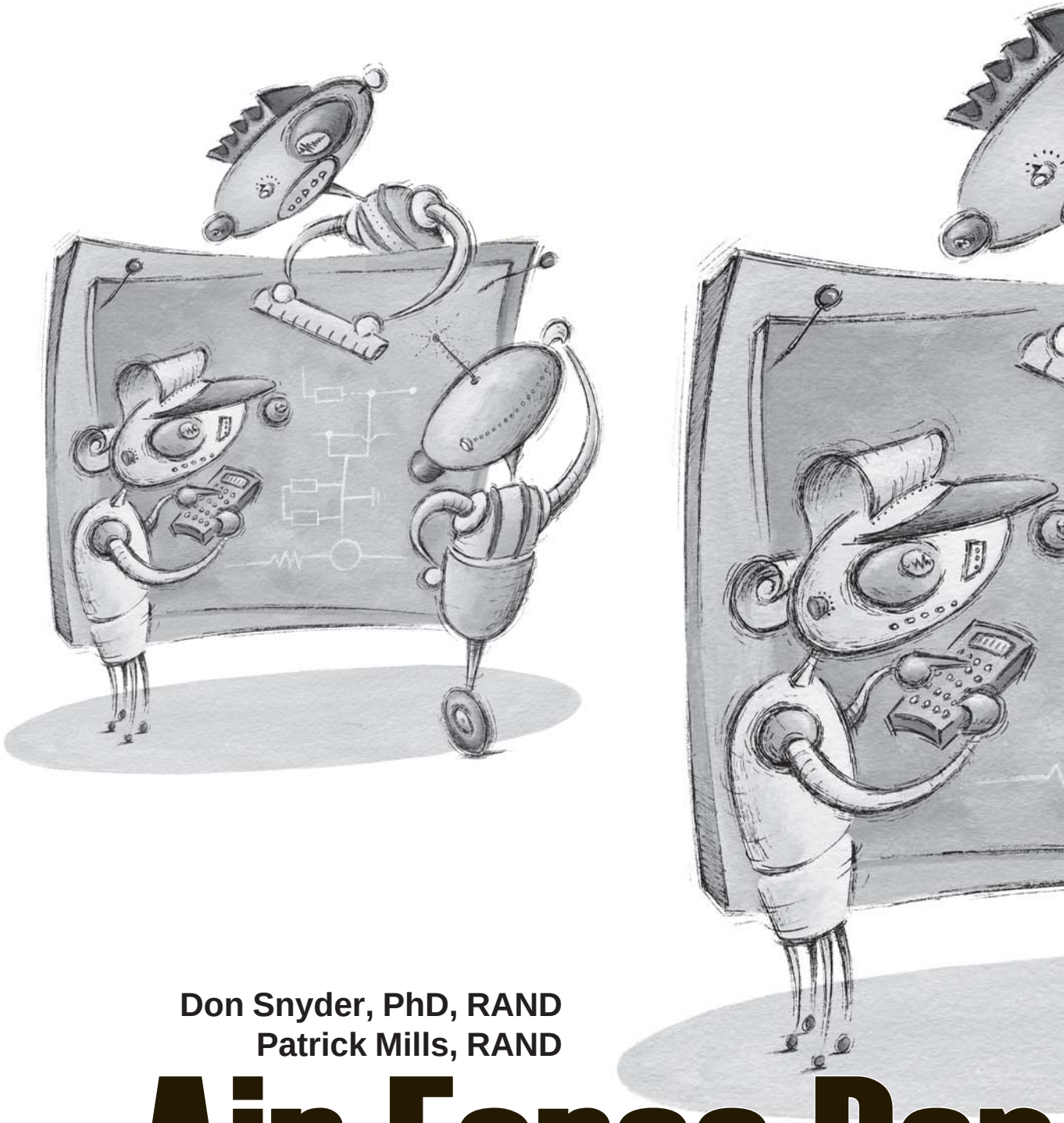
logistics Dimensions 2006

Air Force Deployments: Estimating the Requirement
Mending a Seam: Joint Theater Logistics

Structuring logistics to meet deployment and expeditionary requirements is one of the major dimensions of logistics today. Both of the featured articles examine ways to respond to the challenges associated with this dimension. The first article looks at what may be a better way to estimate Air Force deployment requirements. In this article, RAND proposes a parameterized rules-based approach for estimating deployment requirements. This method combines the speed at which planning can be done using force modules with the accuracy of the ad hoc approach.

There are many logistics seams between the *point of origin and the point of consumption*, but the largest seam is where strategic logistics meets theater logistics. The US military has done well at placing emphasis on strategic logistics. What it has not done is place that same emphasis and importance on theater logistics. Historically, the US military has a record of waiting until a contingency erupts to produce a theater logistics operation that gets the job done.

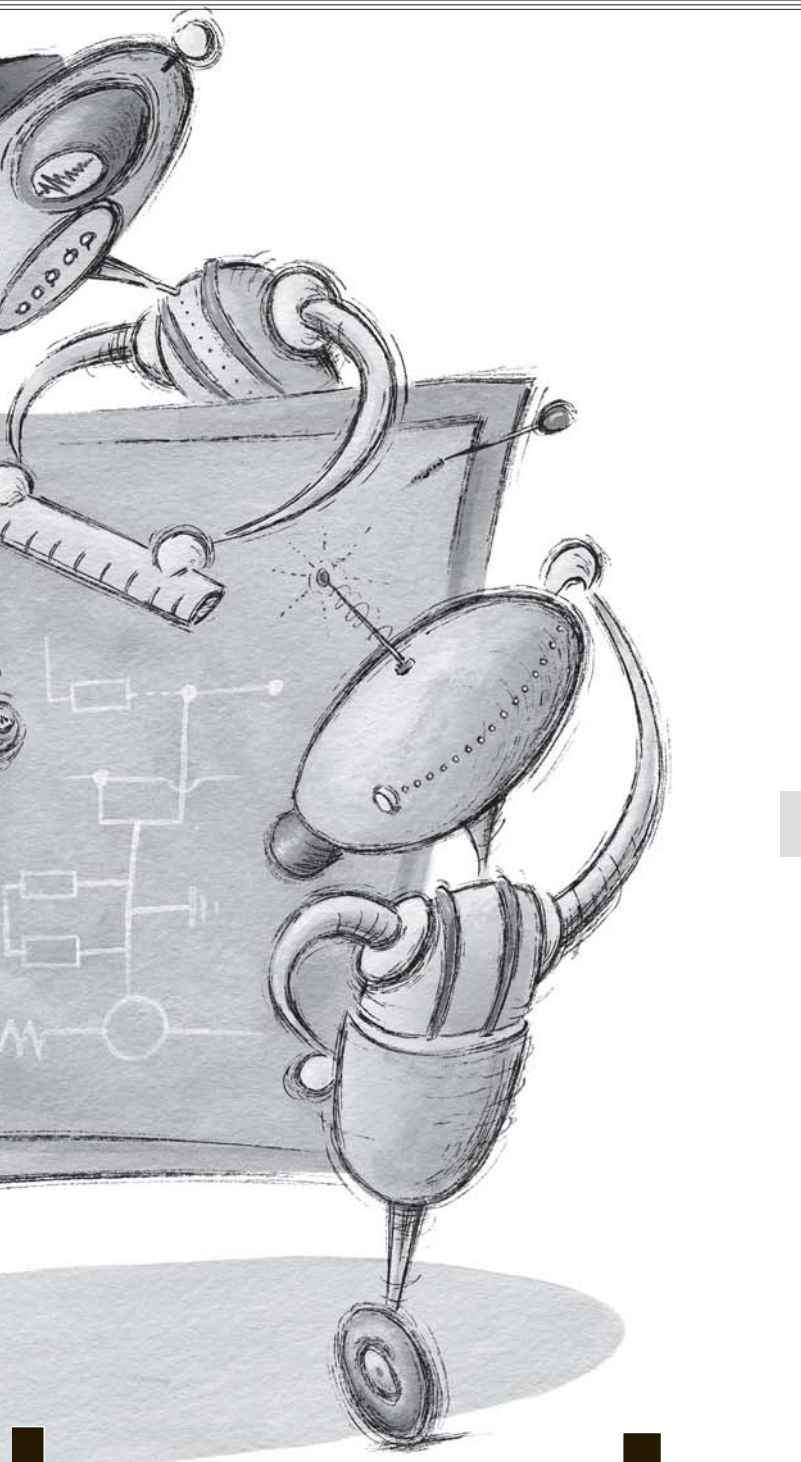
The second article examines a way to *mend this seam.* In it the article posits that by creating a Joint weapon system out of the Deployment and Distribution Operations Center (XDDOC) concept, the Department of Defense can mend the strategic-to-theater logistics seam and provide true Joint theater logistics. The XDDOC concept is not a panacea, but it appears to provide great promise towards improving theater logistics.



Don Snyder, PhD, RAND
Patrick Mills, RAND

Air Force Dep

Estimating th



loyments
e Requirement

Introduction

Flying combat aircraft out of deployed locations frequently requires deploying thousands of people and thousands of tons of equipment. Determining how much and what kind of each is not easy. Nevertheless, deploying the right amount and types of equipment and people is very important, both during the execution of contingency operations and for planning purposes. During operations, not having enough resources causes risk of not being able to perform the mission. Taking too much risk delays operations, because of unnecessarily tying up lift, or impairs operations elsewhere by unnecessarily tying up resources. During planning, misestimating the resources needed for deployments may lead to a force structure of the wrong size or balance to meet future national security needs.

Special Feature

Whether done for executing a contingency operation or for planning purposes, deployment resource requirements are principally expressed in the form of unit type codes (UTCs). UTCs are sets of equipment and manpower resources needed to perform a specified capability. They vary considerably in size, and the requirements for a deployment to a single base can involve over a hundred UTCs. Various approaches have been used to estimate which UTCs are needed for deployments.

Force Deployment Requirements

The direct way is to assemble an ad hoc group of subject matter experts for all relevant functional areas and have them assess their resource needs given relevant operational details of the contingency. We call this the ad hoc approach to deployment planning. This approach generally begins with a site survey and input information from operational planners giving details of aircraft to be bedded down, sortie rates, and other relevant factors. Requirements for each functional area are estimated by experts in that area. For example, given the size and numbers of aircraft expected at a base, civil engineers can estimate the water flow needed to meet fire-fighting needs. From this estimate, they determine how many and what types of trucks to deploy. Given the trucks, they in turn estimate the manning and managerial staffing. Other functional areas go through similar, often more complicated, procedures to estimate their resources. For many functional areas, however, the work does not stop at this point because the resource requirements in one area may impact another. For example, civil engineers planning for base support needs—such as number of billets and water and power requirements—need to know how many personnel are expected

Article Highlights

During planning, misestimating the resources needed for deployments may lead to a force structure of the wrong size or balance to meet future national security needs.

In "Air Force Deployments: Estimating the Requirement," the authors propose a parameterized rules-based approach for estimating deployment requirements. This method combines the speed at which planning can be done using force modules, with the accuracy of the ad hoc approach. It extends the concept of force modules from a list of unit type codes (UTC) that support nominal operations out of a generic base to an algorithm that generates a list of UTCs needed at a base that has specified infrastructure and supports specified aircraft and mission. The emphasis is on assembling the *rules* for selecting UTCs rather than assembling *lists* of UTCs. This methodology is called a *parameterized rules-based* approach to calculating deployment requirements. A prototype algorithm using a parameterized rules-based approach for estimating deployment requirements was recently developed by RAND, and is called the Strategic Tool for the Analysis of Required Transportation (START).

Such an approach is based on the principle that needs can be calculated accurately enough for planning purposes given a small set of driving factors. Many functional areas exercise such rules implicitly during planning. Most support needs can be estimated from the following: the number, type, and sortie rates of the aircraft at the location, and whether they are bedded down at the site, or use it as an enroute base; the level of risk that the site has from conventional and nonconventional attack; and a limited number of attributes of the existing infrastructure at the base, such as whether the base has a hydrant fueling system available to the deploying forces, if any billeting is available, and so forth. With these few driving factors and a set of rules, UTC lists can be estimated for most functional areas.

Rules for UTC deployment were developed by consulting a number of senior noncommissioned officers and logistics readiness officers. For purposes of demonstrating the concept, the following functional areas were covered: deployed communications, bare-base support, civil engineering (engineering craftsmen, fire protection, explosive ordnance disposal, and at the site. This number is determined by the sum of all the other functional areas' requirements. This interdependency forces some communication among the functional area experts, or iteration of estimates, or both. The process necessarily engages numerous personnel and consumes considerable time.

A second way is to determine, in advance of deployments, what is expected to be needed for a nominal deployment location. Such an effort has been recently pursued in the form of force modules. Force modules are sets of UTCs for supporting operations at a nominal location. Within the Air Force, the current implementation of force modules has been developed to estimate the resources needed to operate out of an austere deployed location. Five force modules have been developed.

- Open the base
- Establish the base
- Operate the base
- Provide command and control
- Generate the mission.

These modules represent an integrated capability that crosses many functional areas. The modules not only list UTCs, but also specify the order in which they need to arrive. The task of creating these force modules and testing their deployment at the Eagle Flag exercise has caused UTC contents and sizes to be adjusted for modularity.

Force modules can be viewed as a special case of the ad hoc approach to planning. Groups of subject matter experts have gone through the same process of building a UTC list as in the case for real deployments, except in the case of force modules, the target location is a generic, nominal bare base. Some of the assumptions made in the development of force modules are as follows.

- The base has a water source that can be made potable within 10 days.
- The base has limited fuel storage capability, but fuel is available from the host nation.
- General purpose vehicles can be obtained from the host nation.
- The base has a low to medium threat exposure.[1]

Having studied in advance the needs of a nominal deployed location and made a list of the required UTCs clearly saves time and effort when executing contingencies.

Both of these approaches to estimating deployment requirements have benefits and shortcomings. To see these more clearly, consider the Air Force expeditionary activities of the past few years. To support these contingencies, the Air Force has deployed to dozens of locations, nearly all of them unique in their support requirements. Total numbers of Air Force aircraft at these sites ranged from fewer than ten to more than a hundred. Different airframes have been collocated more often than not. In over half of the locations, aircraft from other services or coalition partners have shared the base with the Air Force. Additionally, the existing infrastructure at these locations varied widely. A few are truly bare bases, whereas more commonly, the airfield has some kind of usable infrastructure that reduces the resources the Air Force needs to deploy, such as an international airport or

coalition partner military airbase. Locations with usable infrastructure also vary considerably, both in the nature of the infrastructure and in how much is made available to deploying forces. Locations of recent deployments indicate that not only is there no typical base in the sense of infrastructure and numbers and types of aircraft, there are scarcely two that are alike.

How well do the ad hoc and force-module approaches handle the vicissitudes of these demands on expeditionary planning? Suppose, for the purpose of sizing the future force, the Air Force needed to estimate the deployment requirements for activities resembling recent contingencies. The ad hoc approach is capable of making good estimates of the UTCs needed to support operations at each of the locations. This accuracy, however, comes at a high cost in time, money, and manpower. Assembling these UTC lists can take teams of experts weeks or months. The costs can be prohibitive, especially if the number of sites to be investigated is numerous, or the number of scenarios to be examined are many.

Force modules economize on the time, money, and manpower of assessing requirements by having standardized these in advance. This economy was indeed one of the main motivations for their creation. Their weakness is that they do so for a generic base, yet no characteristic generic deployed location has emerged from recent deployments. The bases of interest in planning may depart significantly from the one envisioned in the development of the force modules, including such sites as international airports. Without tailoring, force modules fail to accurately capture the nuances of deployment requirements involving a range of base types and mixes of aircraft. These differences will reduce the economies of effort that the force modules would provide had they been able to account for the enormous range in types of Air Force deployed operations. Further, when used to size and shape the future force, they may not generate the best mix of capabilities to meet national security objectives given a constrained budget.

Here, we introduce a third way to estimate deployment requirements. The proposed method combines the speed at which planning can be done using force modules, with the accuracy of the ad hoc approach. This method extends the concept of force modules from a list of UTCs that support nominal operations out of a generic base to an algorithm that generates a list of UTCs needed at a base that has specified infrastructure and supports specified aircraft and mission. The emphasis is on assembling the *rules* for selecting UTCs rather than assembling *lists* of UTCs. We call this methodology a *parameterized rules-based* approach to calculating deployment requirements. A prototype algorithm using a parameterized rules-based approach for estimating deployment requirements was recently developed by RAND, and is called the Strategic Tool for the Analysis of Required Transportation (START)[2].

A Prototype: The RAND START Algorithm

A parameterized rules-based approach for estimating deployment requirements rests on the principle that expeditionary needs can be calculated accurately enough for planning purposes given a small set of driving factors. Consultations with subject matter experts in a range of support areas confirm this supposition[3]. Many functional areas exercise such rules implicitly during planning, such as the fire-fighting example given above. Most support needs can be estimated from the following.

Article Highlights

readiness), medical, force protection, fuels support, aviation and maintenance, and aerial port operations. The rules were vetted by calculating the needs for a variety of deployments and having these examined by subject matter experts not involved in the consultations used to establish the rules. Generally this meant conferring with experts from one major command to derive the rules, and consulting experts from another major command to vet the results. The method is similar to what is done in assembling UTC lists by the ad hoc method, or making the UTC lists that constitute force modules, except that what is being assembled is rules rather than UTCs.

The resulting rules were incorporated into Visual BASIC for Applications code hosted in an Excel spreadsheet. The Excel spreadsheet contains a list of available UTCs directly imported from the manpower and force packaging database. The user specifies operational details at approximately the level of an air order of battle. Inputs are in the form of checklists that specify the following parameters: which aircraft are bedded down at the location (or use it as an enroute location), how many of each type, their sortie rate, and mission. Some high-level aspects of the available base infrastructure can be selected, such as whether a fuels hydrant system is available, or how much billeting may be available. The user also indicates whether the threat to the base is high, medium, or low for both conventional and nonconventional attack. Finally, a working maximum on ground can be specified in order to estimate aerial port equipment and manpower. From these inputs, planning factors are used to calculate base population. The algorithm then takes these parameterized inputs and uses the rules to determine which UTCs are needed and how many. The algorithm searches the MEFPAK for these UTCs and collects the movement data that is compiled in the MEFPAK. The final output is a list of UTCs and their associated movement characteristics.

Article Acronyms

AEF - Aerospace Expeditionary Force
MEFPAK - Manpower and Force Package
MOG - Maximum on Ground
START - Strategic Tool for the Analysis of Required Transportation
UTC - Unit Type Code

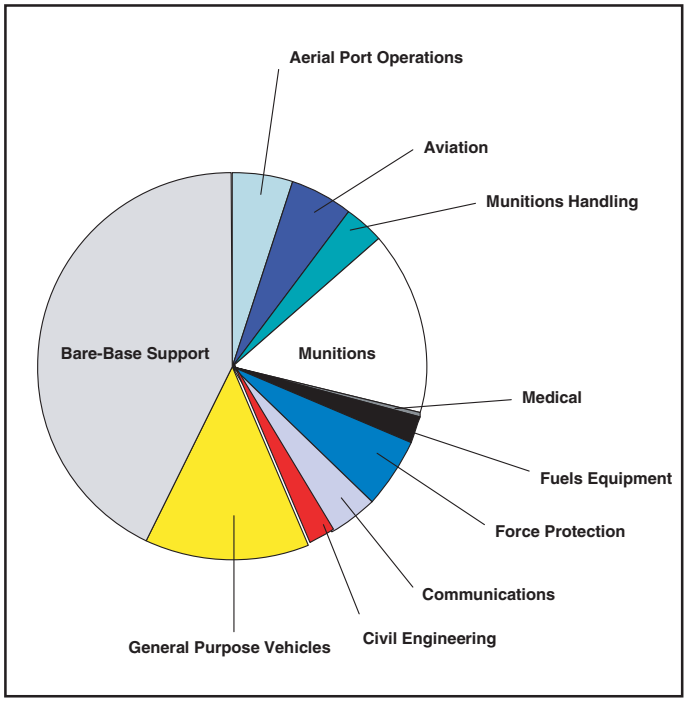


Figure 1. Summary of Support Requirements for a Deployment of a Squadron of F-16CJs and a Squadron of C-130s at One Location

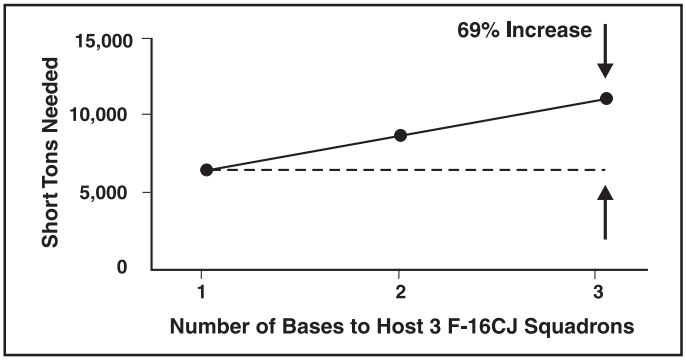


Figure 2. Plot Showing the Increase in Support Needs if 54 F-16CJs are Based at One, Two, or Three Bare Bases

- The number, type, and sortie rates of the aircraft at the location, and whether they are bedded down at the site, or use it as an enroute base
- The level of risk that the site has from both conventional and nonconventional attack
- A limited number of attributes of the existing infrastructure at the base, such as whether the base has a hydrant fueling system available to the deploying forces, if any billeting is available, and so forth

With these few driving factors and a set of rules, UTC lists can be estimated for most functional areas[4].

We assembled rules for UTC deployment by consulting a number of senior noncommissioned officers and logistics readiness officers. For purposes of demonstrating the concept, the following functional areas were covered: deployed communications, bare-base support, civil engineering (engineering craftsmen, fire protection, explosive ordnance disposal, and readiness), medical, force protection, fuels support, aviation and maintenance, and aerial port operations. The rules were vetted by calculating the needs for a variety of deployments and having these examined by subject matter experts not involved in the consultations used to establish the rules. Generally this meant conferring with experts from one major command to derive the rules, and consulting experts from another major command to vet the results. The method is similar to what is done in assembling UTC lists by the ad hoc method, or making the UTC lists that constitute force modules, except that what is being assembled is rules rather than UTCs.

The resulting rules were incorporated into Visual BASIC for Applications code hosted in an Excel spreadsheet. The Excel spreadsheet contains a list of available UTCs directly imported from the manpower and force packaging (MEFPAK) database. The user specifies operational details at approximately the level of an air order of battle. Inputs are in the form of checklists that specify the following parameters: which aircraft are bedded down at the location (or use it as an enroute location), how many of each type, their sortie rate, and mission. Some high-level aspects of the available base infrastructure can be selected, such as whether a fuels hydrant system is available, or how much billeting may be available. The user also indicates whether the threat to the base is high, medium, or low for both conventional and nonconventional attack. Finally, a working maximum on ground (MOG) can be specified in order to estimate aerial port equipment and manpower. From these inputs, planning factors are used to calculate base population[5]. The algorithm then takes these parameterized inputs and uses the rules to determine which UTCs are needed and how many. The algorithm searches the MEFPAK for these UTCs and collects the movement data that is compiled in the MEFPAK. The final output is a list of UTCs and their associated movement characteristics[6].

Illustrative Applications

The most straightforward illustration is calculating the requirements for a single base hosting a mix of aircraft. Figure 1 shows the requirements for a deployed location with 18 F-16CGs flying 1.5 sorties per day, and 8 C-130s, each flying one sortie per day out of a bare base with a MOG of 2. The threat levels for both conventional and nonconventional attack are taken to be low. This calculation takes a few seconds using the START program. The figure summarizes the requirement in terms of weight; for all functional areas calculated, the sum is 4,775 short tons. These results not only give a planner an excellent starting point for assembling an executable UTC list, but also provide a first-order estimate of the movement requirements. A user can adjust parameters such as the numbers of aircraft, their sortie rates, and so forth in order to examine the impact on the required UTC list. The power of the method is that the UTC list is not static, but can be derived from variations in these input parameters.

Now consider the issue of force lay down as an implicit parameter. For example, what is the difference in the support requirements of the following alternative for the lay down of 3 squadrons of F-16CJs flying 1.5 sorties per day: (1) all three collocated at one bare base; (2) two placed in one bare base and one in a second bare base; or (3) each squadron deployed to its

own bare base. Figure 2 shows the results, aggregating all equipment resources in terms of weight. To emphasize the resources that are likely to be deployed, the figure excludes general purpose vehicles. Placing the same numbers of aircraft flying the same mission at three bases rather than one increases the total support materiel by nearly 70 percent. This figure may be an underestimate of the increase, as it does not take into account the likely reduction in personnel needs that the economies of scale of a single base provides. The ability to perform tailored calculations like these can be a useful guide during both deliberate and crisis-action planning.

Finally, note that the algorithm can be used in two directions. A scenario can be created, and the deployment requirements calculated to meet those operational needs. The above calculations are examples of this direction, and this is useful in obvious ways for crisis-action planning, and planning for force sizing. Alternatively, a capability could be specified, such as the ability to deploy a set of aircraft to a number of sites of certain types. The required resources could then be compared with those currently authorized or available. This direction provides a nuanced way to express Air Force expeditionary capabilities, such as how many bases of a certain type can be supplied by an aerospace expeditionary force (AEF).

Implementing a Parameterized Rules-Based Approach to Deployment Planning

The program we have described is a prototype, concept demonstrator. Additional work will need to be done to make this approach operational. Much of the knowledge needed to implement a parameterized rules-based approach to estimating deployment requirements already exists. A knowledge base of rules for deployments has been developed by most functional areas, and if not yet formalized, exists *virtually* in the subject matter experts.[7]

Areas that have already developed algorithms to assist in estimating deployment, such as fuels support, can furnish such rules without further effort. For most areas, the rules need to be assembled. These could be assembled by a similar effort as was made in creating the force modules.

Caution should be exercised in extracting rules from historical deployments. We did not use historical data in assembling the rules in the prototype START program. Aside from the limitations of knowing what was not requested during a contingency (because it was already available), and the general reality that operational needs change nearly continuously with time, it is difficult to separate needs from wants. Materiel and manpower may be requested during an operation not just to cover the operational needs of the time, but also to mitigate risk in case of an unplanned surge in operations. These needs can be difficult to separate.

Once compiled, rules need only be maintained during the routine management of UTCs. As part of the introduction of new UTCs, the pilot unit could be responsible for developing rules for their deployment, just as they now are responsible for estimating movement characteristics. A secondary benefit of this process may be that it impacts the development of UTCs in the same constructive way that force modules have. A parameterized rules-based approach may reveal aspects in which the sizing and constitution of UTCs might be improved to meet expeditionary needs. For example, in some areas, parameterization and rules collection might reveal value in establishing separate UTCs to supply a given capability to a bare base versus an international airport.

We hope this prototype effort will lead to the next step in the evolution of the force module concept, one that moves from UTC lists to sets of rules for deployment. Doing so should further advance the expeditionary mission of the Air Force.

Once compiled, rules need only be maintained during the routine management of UTCs.

Notes

1. Lt Col Raymone Mijares, Presenting the AEF-AETF Force Modules, 2005.
2. Don Snyder and Patrick Mills, *A Methodology for Determining Air Force Deployment Requirements*, RAND MG-176-AF, 2004. The emphasis on transportation in the name START is because the algorithm was initially written as a component in an analysis of minimizing lift costs for deployments.
3. Don Snyder and Patrick Mills.
4. Other factors can play a role. For example, base layout and topography may influence the needs for vehicles and place greater demands on security forces. If topography impedes line-of-sight communications at the base, additional communications equipment may also be needed. These are secondary factors, and results can be tailored to accommodate these factors when they play a significant role.
5. In the START program, these planning factors for base population are used directly. Further refinement would use these estimates as *seeds* to calculate all manpower needs, then use the sum of the manpower needs as a second estimate of base population. The calculation would then be iterated until convergence.
6. No time-phasing or sourcing of the UTCs is currently done. Time-phasing could be introduced as a further refinement, and the outputs could easily be used as the inputs to an algorithm that does sourcing.
7. Lionel A. Galway, Mahyar A. Amouzegar, Richard J. Hillestad, and Don Snyder, *Reconfiguring Footprint to Speed Expeditionary Aerospace Forces Deployment*, RAND MR-1625-AF, 2002; Lionel A. Galway, Mahyar A. Amouzegar, Don Snyder, Richard J. Hillestad (2002) "Footprint Configuration: An Essential Element for Agile Combat Support in the EAF," *Air Force Journal of Logistics*, Vol XXVI, No 4, 20-26, 43; Don Snyder and Patrick Mills, *A Methodology for Determining Air Force Deployment Requirements*, RAND MG-176-AF, 2004.

Don Snyder is currently a senior physical scientist with RAND. Patrick Mills is an associate operational research analyst with RAND.

Visit the *Journal* online at: http://www.aflma.hq.af.mil/lgj/Afjlhome.html