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2000

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Point of View

Seamless Supply
(Or the Lack Thereof)

Colonel William Stringer
USAF, Retired

RBL, the acronym for Readiness-Based Leveling, is a misnomer in that it does not directly address readiness in terms of readiness goals by weapon system or by unit. It assumes that all weapon systems are equal in mission importance and all SRANs [stock record account numbers] are equally important.

RBL was created to allocate the near-term D041 levels by SRAN, with the goal of capping SBSS [Standard Base Supply System] requisitions to the allocations. In that sense, it was similar to the Hi-Valu levels negotiated by the ALCs [air logistics centers] with each MAJCOM [major command] for their bases during mid-1950 to the late 1960s. A separate data system was required since the D041/RDB [requirements data bank] *Mafia* refused to calculate levels by SRAN or even by weapon system although the data has been provided by SBSS for many years. The RBL allocation is based on the base-specific factors randomly provided by SBSS. Since RSP [Readiness Spares Package] levels are accepted blindly by D041, RBL makes the same assumption even though RSPs duplicate POS (peacetime operating stock) levels.

The fundamental issue is that the D041 level (and supporting factors) is not accurate due to many factors, including inaccurate application data, inaccurate program data, incomplete/inaccurate I&S [interchangeability and substitute] data, IMS (inventory management specialist) file maintenance errors, etc. Imposition of Air Staff goals, such as D041 ceilings on BRC (base repair cycle time) and OST (order and shipping time), also artificially changed the true D041 requirement. D041 (and RBL/EXPRESS [Execution and Prioritization of Repair Support System]) essentially ignore two-level maintenance and the related Air Staff goals. Finally, since D041 is not financially constrained, its requirements are often not financially supportable.

> **The summer 1999 AFJL *article "Demystifying RBL" prompted me to send you my comments not just on RBL but related matters and are based on my, admittedly, incomplete understanding of the real world.***

The lack of an authoritative source of application data is the key D041 problem. If a specific application is not recorded for an NSN [national stock number], the related program data does not compute a level. The following example shows the extent of the problem. In the June 1998 D041 computation, the count of NSNs that had F-15 or F-16 application data are shown in Table 1.

Series	F-15	F-16	C-5
A	3,910	3,727	6,548
B	3,940	3,536	2,668
C	3,159	13,435	2,528

Table 1. NSNs with F-15/F-16 Application Data

These statistics suggest that D041 does not know what NSNs apply to what MDS [mission design series], much less the application percent by block number or other sub-MDS aggregation. It's also a major problem for other data systems relying on D041 application data.

Although SBSS provides the SRD (Standard Reporting Designator) in DAC (RTS [reparable this station]/NRTS [not reparable this station]/Condition) transactions and in MICAP [mission capable] data, this information has never been used by AFMC [Air Force Materiel Command] to update their application data or to challenge the reporting activity. In addition, AFMC has declined to task the applicable single managers to validate the D041 application data or to pursue alternative configuration accounting/management approaches.

The earlier RBL policy decisions included requisitioning as a cross-check on the many known D041 errors and to preclude shipping an item to a SRAN that had not expressed a need via requisitioning. The significant over-requisitioning/excess ALC due-out rate suggests that the cross-check is ineffective.

The number of ALC due-outs that exceed the RBL-limited assets is so large as to make the current EXPRESS logic questionable. The 52 C-5 NSNs in the GAO [Government Accounting Office] report (NSIAD/AIMD-99-77, April 1999, *Air Force Supply Management Actions Create Spare Parts Shortages and Operational Problems*) showed an excess ALC due-out total of 26 percent of all ALC due-outs.

The 26 percent difference may be due to (1) SBSS over-requisitioning, (2) AFMC errors in processing base due-in cancellations, or (3) errors in the base due-in/depot due-out reconciliation (MOV [materiel obligation validation] process.

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Part 3

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Supporting expeditionary operations presents new challenges to the Agile Combat Support System.

The increasing number of deployments launched on short notice to unpredictable locations presents new challenges to Air Force personnel and capabilities.[1] Further, continued political expectations for a high-operating tempo and rapid response capability have forced the Air Force to develop new concepts of operation. Together, these have led the Air Force to develop the Expeditionary Aerospace Force (EAF) in order to provide sustainable, quick-strike capabilities to project power world wide.[2] The F-15 weapon system will play an important role in the EAF for several years in the future. This article examines how alternative F-15 support structures shape the effectiveness and efficiency of EAF Agile Combat Support (ACS).

New Logistics Concepts for Meeting EAF Challenges

Supporting expeditionary operations presents new challenges to the ACS system. Support elements and operations must: (1) spin up to sustain operations almost immediately, (2) minimize airlift demands to increase the rate of deployment, and (3) have the flexibility to respond to the demands associated with highly uncertain locations and mission demands. At the same time, cost pressures remain, and the personnel implications of an expeditionary force must be weighed against recruiting and retention issues. The need to balance these sometimes contradictory challenges has led the Air Force to reexamine the complete ACS system to understand how alternative structures, technologies, and methods affect costs and capabilities.

RAND and Air Force Logistics Management Agency researchers have been exploring promising alternative support concepts to support the EAF operational strategy. Comparisons of these concepts to each other and to the current system have been based upon six Air Expeditionary Force (AEF) logistics metrics: spin-up time, airlift footprint, operational risk, operational flexibility, investment, and recurring costs. Analyses indicate that varying the structure according to support location proximity to operations—with the operational unit at another forward location in theater or in the continental United States (CONUS)—creates trade-offs among logistics metrics. In some instances, technologies and process methods can change the trade-offs inherent in a given structure, reducing negative features while preserving positive ones.

This article specifically examines alternative F-15 avionics intermediate maintenance structures and explores how different technology and process capabilities affect the likely cost and performance of the structures. The level of support consolidation and proximity to the fighting units, ranging from the current decentralized practice of deploying intermediate maintenance with the deploying unit to a small network of support locations (or even a single location), characterizes the alternative structure options. Technologies, policies, and capabilities combine with the structure options to form a rich array of possibilities from which the Air Force may choose the best ACS system to meet uncertain scenarios. Our goal is to highlight the key issues affecting the possible decisions and to illustrate some of the trade-offs the Air Force faces in these decisions.

Support Structures, Policies, and Technology Create the *Trade Space*

The analysis centers on the level of consolidation chosen for support operations. The Air Force currently decentralizes F-15 avionics maintenance by deploying testers from home bases to forward operating locations (FOL) with aircraft. A variation of this system is the *decentralized no deployment* option in which the avionics intermediate shop (AIS) would not deploy with its squadron to FOLs during combat operations. Other options rely on varying levels of consolidation. These range from using a single CONUS support location (CSL) to using a CSL in network with two to four forward support locations (FSL).

While structure decisions may focus on support locations, they should not do so exclusively. Adopting new procedures or technologies can affect how different support structures compare to each other. Considering faster order and shipping times (OST) than those achieved today can provide insights about the logistics system that can justify a push for new

F-15 support analysis

Exploring F-15 Avionics Intermediate Maintenance Concepts to Meet

AEF Challenges

transportation concepts or processes. Implementing new technology such as the new electronic system test set (ESTS) is also likely to affect the six AEF support metrics.

In analyzing different support structures for the AEF, an employment-driven modeling approach or an approach shaped by mission and support requirements and options was used.[3] The first step in this approach is shown in the left panel of Figure 1. In analyzing mission requirements, force employment models are used to determine the force package and operating tempo necessary for anticipated missions.

This information is used to estimate initial deployment and subsequent sustainment requirements, as shown in the middle panel of Figure 1. The demand for avionics components then drives the requirements for maintenance equipment and personnel, spare parts, and transportation resources. The last step in this process is to determine the spin-up time, airlift footprint, cost, risk, and flexibility of each option, as shown in the right panel of Figure 1. In some cases, this will show that all of the alternatives are incapable of meeting operational needs. If this is the case, it should guide modification of mission planning or development of new alternatives. In this way, logistics and operations planners can work together in an iterative process until the best solution, given resource constraints, is reached. At the end of the process, mission requirements and logistics capabilities should be consistent and well understood.

Costs

The study examined several types of costs across six support structures for F-15 intermediate avionics maintenance. These costs include those for testers, personnel, spare parts, and transportation. As mentioned, the six support structures analyzed are defined primarily by level of consolidation. These are (1) the current decentralized system, (2) a *decentralized no deployment* system, (3) a network of four FSLs and one CSL, (4) a network of three FSLs and one CSL, (5) a network of two FSLs and one CSL, and (6) use of only one CSL for avionics maintenance.

Tester Costs

For the current decentralized system, $12M is needed for additional Tactical Electronic Warfare Intermediate Support System (TISS) testers. Analysis shows the Air Force currently lacks the six TISS stations needed to meet wartime requirements for two coincident major theater wars (MTW). This cost would not be incurred for the centralized structures, because these structures would require fewer total testers. In this case, the current decentralized inventory is more than sufficient. In fact, with the current testers, analysis indicates consolidated support would cut worldwide tester requirements by 50 percent.

For the ESTS configuration, costs include remaining program funds and, for the decentralized structure, $22M for the additional procurement of three ESTS units and six TISS testers. With ESTS, consolidation would cut total tester requirements by about a third. As with current testers, this reduced tester requirement does not produce savings, because existing tester inventory (including funds already expended for ESTS) is a sunk cost.

Personnel Costs

Based upon fully burdened Air Force personnel costs[4] for the authorized grades and skill levels planned for staffing and supervising test stations,[5] personnel costs are estimated to be about $42K per person. Expressed in 8-year, net present value (8-year NPV) terms,[6] total personnel costs necessary to satisfy two MTW demands, using the current testers, range from about $450M with complete consolidation to nearly $900M for the decentralized structure. Personnel costs using the ESTS range from about $400M with consolidation to about $650M for the decentralized structure. The model suggests the need for a slight increase in Air Force avionics maintenance personnel if the Air Force adopts ESTS under the current structure, while consolidation would allow a reduction in personnel.

Spare Parts Costs

Spare parts costs increase as consolidation increases, because the length of the resupply pipeline increases. While consolidation yields some economy-of-scale *savings* for shop replaceable units, these savings are overwhelmed by the demands of longer pipelines for line replaceable units (LRUs). To support the consolidated options, new spares concepts were developed, including a buffer stock at the consolidated sites to help ensure serviceable spares are available when requisitioned by a deployed unit. This is more cost effective than further increasing the depth of Readiness Spares Packages (RSP). These buffer stocks are referred to as Consolidated Spares Packages. In addition, the RSP that would support deployed options was changed to contain LRUs only, since avionics intermediate maintenance would not be deployed under the consolidated

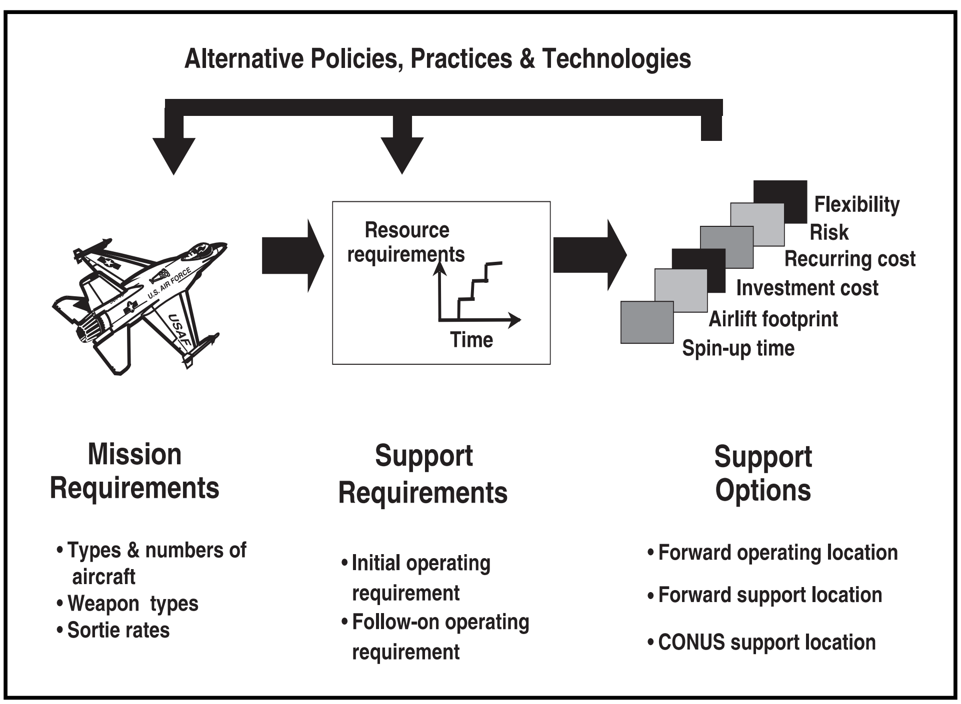

Figure 1. Employment-Driven Modeling Approach for Evaluation ACS Systems

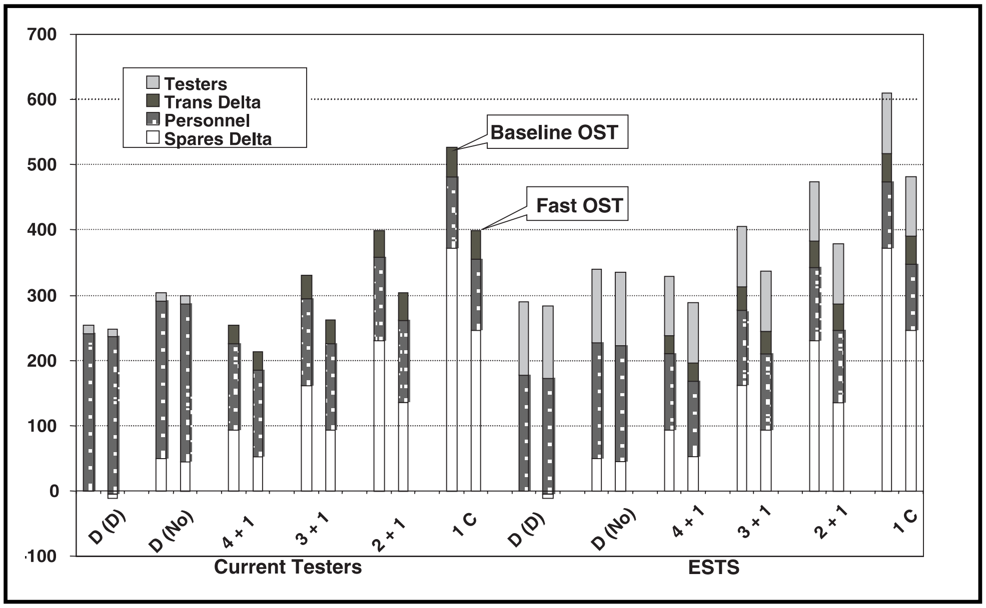

Figure 2. Total Cost by Structure, OST, and Tester Configuration

options. Finally, peacetime operating stocks were adjusted to support the pipelines between operating and repair locations.

Using today's order and shipping times would require an additive spare parts inventory cost of nearly $100M for the CSL/4 FSL option and more than $350M for the CSL-only option. Reducing OST, thereby reducing the pipeline length, greatly reduces these additive spare part requirements. For example, with OST 2 to 3 days shorter than current times, additive spare parts costs for the CSL/FSL combinations are about $50M. For the CSL-only option, the cost is about $250M.

Transportation Costs

In the current decentralized system, unserviceable three-level (remove-repair-replace) items are repaired on base and do not require transportation to a repair facility. In a remove-and-replace system used for consolidation, all unserviceable items must be shipped from FOLs or home bases to an FSL or CSL, and a serviceable part must be shipped back. Again, as consolidation increases, parts transportation costs increase, because fewer operating bases are colocated with repair facilities, producing an increasing reliance on transportation. Estimates, based on analysis, show the 8-year NPV of these transportation costs to vary from $28.1M for CSL/4 FSL structure to $44.4M for a single CSL.

Total Costs

The sum of 8-year NPVs for equipment, personnel, spares, and transportation equals the total costs for each option and test set, as shown in Figure 2. With base-line OSTs and the current tester configuration, the decentralized deployment option and the CSL/4 FSL option are nearly equal in total cost. The two options essentially trade off personnel and spare parts costs.

For the ESTS configuration with base-line OSTs, shown on the right side of Figure 2, the decentralized option costs slightly less than the CSL/4 FSL option, because the ESTS itself reduces personnel requirements.

Improved OSTs reduce the requirements for spare parts while keeping other costs constant. This makes the CSL/4 FSL option the low-cost option for using current testers. For ESTS with improved OSTs, the CSL/4 FSL option and the current decentralized support structure are about equal in costs.

Other Requirements by Structure

There are other critical dimensions beyond cost to consider in making support structure decisions. These include deployment personnel requirements and quality-of-life issues, deployment footprint, and operational risks.

Deployment Personnel Requirements

Among the goals of the AEF is deployment predictability to provide stability for Air Force personnel. In this analysis, this goal is taken one step further by analyzing how to reduce deployment personnel requirements, not just how to make the requirements more predictable. The current decentralized deployment option has high deployment personnel requirements, while the decentralized no deployment option eliminates deployment personnel requirements. The consolidated structures eliminate deployments for small-scale contingencies and require just a small number of people to shift from CSLs to FSLs during major theater wars.

Deployment Footprint

A key element in successful quick-hitting expeditionary operations is the rapid deployment of strong combat forces. This puts a premium on reducing the deployment footprint or the amount of initial airlift space needed to transport initial operating requirements and combat equipment. For an MTW deployment, consolidated and decentralized no deployment structures reduce deployment footprint requirements for avionics intermediate maintenance by up to 60 C-141 (43 C-17) load equivalents. The adoption of the much smaller ESTS would reduce these savings to a maximum of 12 C-141 (9 C-17) load equivalents.

Reducing the deployment footprint provides a vivid picture of an objective that can be achieved in different ways. Either new technology, such as the ESTS, or policy changes, such as those for consolidation, can help reduce the deployment footprint. The key point is Air Force leaders can often choose from a variety of options to meet their operational goals.

Operational Risks

If resupply times for a given support structure do not meet the performance assumptions used to set spare parts levels, then aircraft availability may suffer. In a decentralized structure, the greatest operational risk is tester downtime. If a single set of testers is deployed, a breakdown of just one will temporarily eliminate resupply for a large group of LRUs. This is termed the *single string* risk.

In a consolidated structure, the greatest operational risk is OST and retrograde time performance. While the single string risk can greatly affect a small group of LRUs, OST and retrograde time risk is broader but also likely to be more moderate and gradual.

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expeditionary airpower 2000 AEF

Part 4

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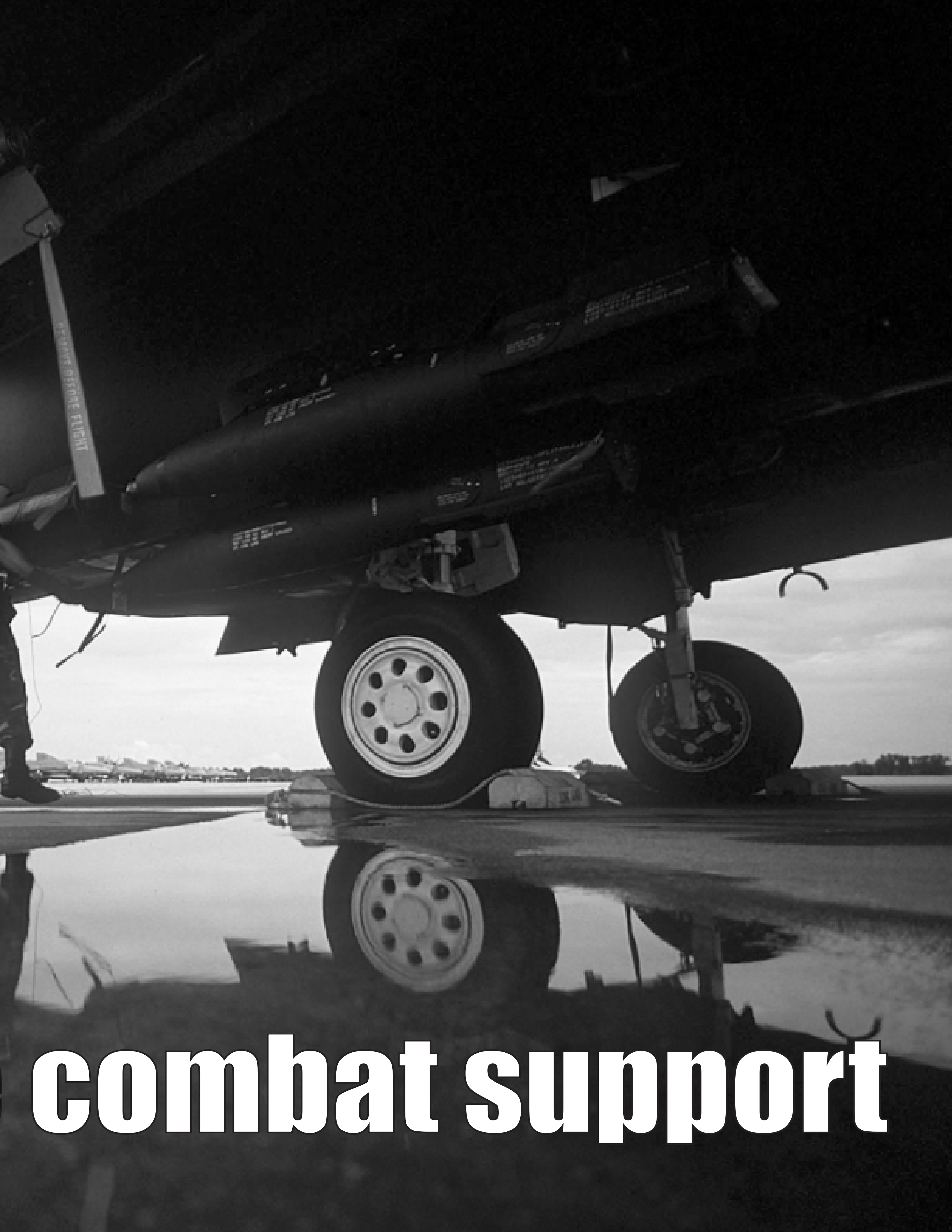
The development of Expeditionary Aerospace Force (EAF) operations requires rethinking of many Air Force functions. This includes the combat support system. To a large extent, success of the EAF depends on turning the current support system into one that is much more agile. In recognition of this, the Air Force has begun transforming the current support system to the Agile Combat Support (ACS system).[1] *It has designated ACS as one of six essential core competencies for Global Engagement.*

Developing the ACS system requires hard decisions concerning allocating the limited resources necessary for creating a system capable of meeting a wide range of uncertain scenarios. ACS requirements will vary with each scenario, and each scenario will require unique trade-offs, such as that between speed and cost or, more generally, between different characteristics valued by the Air Force. These trade-offs will change as support technologies, policies, and practices change.[2] As a result, ACS planning must be a continuous effort.

a vision for agile



e combat support

The system itself must evolve toward a flexible logistics infrastructure that makes the best use of resources and information.[3]

This article offers a vision of what the future ACS system might look like and how it could help the Air Force meet EAF operational goals. This vision draws from ongoing RAND and Air Force Logistics Management Agency (AFLMA) research evaluating how ACS design options impact EAF effectiveness and efficiency. The ACS system will have to support EAF operations ranging from major theater wars (MTW), to small-scale contingencies, to peacekeeping missions.

It will likely need to be a global network that will comprise:

- Forward operating locations (FOL), with resource allocations that support differing employment time lines.
- Forward support locations (FSL), with differing support processes and resources.
- Continental United States (CONUS) support locations (CSL).

These infrastructure elements need to be connected by a logistics command and control (LOG C2) system and a very responsive distribution system in order to ensure support resources arrive when combat commanders need them.

ACS Decisions and Their *Trade Space*

The Air Force recognizes that it must change the current support system to meet the needs of the EAF. Some elements and processes of the current system are remnants of a Cold War system designed to support the needs of large overseas forces that would be employed simultaneously in major conflicts occurring in Central Europe and Northeast Asia. Specific resources were provided to FOLs for waging combat in known places. Planners assumed the resources needed for MTWs would suffice for all lesser conflicts. There was less uncertainty to consider in such a planning environment.

Today, support resources must be designed to meet the needs of a smaller force facing a wide variety of scenarios in uncertain locations. The new planning environment also has limited resources for supporting multiple areas of responsibility (AOR). This means the future support system must be flexible enough to move resources across AORs.

Aviation unit type codes (UTC) were developed to be self-sufficient for 30 days. For EAF operations, UTCs designed for more rapid deployment require a smaller footprint, in turn, requiring immediate resupply after deployment. There must be a shift from reliance on large stockpiles of resources at FOLs to an emphasis on fast resupply to replenish smaller forward stocks.

More generally, support resources must be considered strategically rather than tactically. In the past, support requirements determinations have been made to calculate specific requirements needed to meet commander-in-chief responsibilities. Now support resource calculations and considerations must take into account a wide range of scenarios. Resources need to be distributed to meet wide variations in scenarios. The resulting resource mix may not be the best for any one particular scenario, but it may be the most robust against the entire range of scenarios or the mix that holds up best in the face of uncertainty. Thus, the future ACS system must be flexible, with logistics processes in place to determine how to move limited resources from one place to another in meeting rapid deployment, employment, sustainment, and reconstitution needs.

Specific key variables affecting ACS system design include:

- Options for force composition, employment time line, and operation tempo.
- FOL capabilities, including infrastructure and resources, as well as the political and military risks associated with prepositioning resources at specific locations.
- Technology options affecting performance, weight, and size of test equipment, munitions, support equipment, and other support.
- Resupply time, particularly as it affects initial operating requirements (IOR) and follow-on operating requirements (FOR).
- Alternative support policies, such as conducting repair operations at deployed or consolidated support locations.
- Strategic and tactical airlift capacity.

These and other variables form a rich array of decisions from which Air Force leaders will choose in designing the future ACS system. Generally, there are no right or wrong answers, but system trade-offs will be required.

ACS design decisions will depend on how Air Force leaders value different criteria. Some system needs—such as rapid employment time lines, high operating tempos, and airlift constraints—favor forward positioning of resources. Others, such as the cost and risk of positioning resources at FOLs, favor positioning of resources at consolidated locations.

Figure 1 depicts the general trade-offs. Investment costs are higher for an extensive support structure positioned at numerous forward locations. They decline as the number of support locations declines. Employment time is lower for an extensive support structure with numerous forward locations. It increases as the number of support locations decreases.

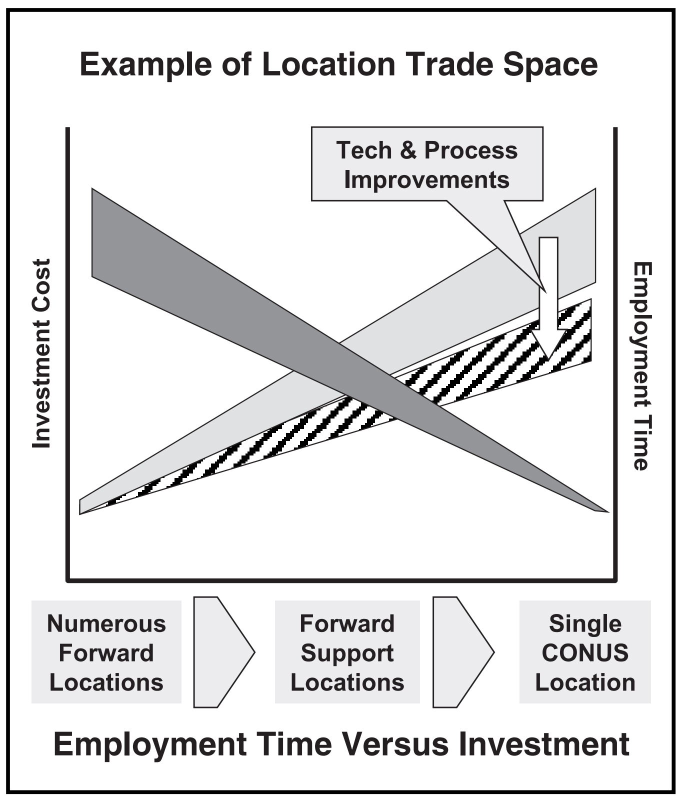


Figure 1. General Decision Trade Space by Location

While the general direction of these relationships is fixed, the specific details are not. The arrow on the graph shows the effect of reengineering processes or implementing new technologies, such as developing lightweight munitions or support equipment. New technologies or processes can shift the time-line curve downward. This allows more rearward positioning of resources than would otherwise be possible.[4]

An Analytic Framework for Strategic ACS Planning

How can Air Force leaders evaluate and choose among ACS options? We propose an employment-driven modeling framework. The core of this framework is a series of models for critical support processes that can calculate equipment, supplies, and personnel needed to meet operational requirements.[5]

These models are *employment driven* because they start from the operational scenario—or from the employment requirements—to provide time-phased estimates of support resource requirements. Once support requirements are computed, the models can be used to evaluate options—such as prepositioning support resources or deploying from consolidated locations—for satisfying them. The evaluation includes metrics such as spin-up time, airlift capacity, investment and recurring costs, and political and military risks. Figure 2 depicts the modeling framework developed in the analyses.

This framework is designed to address the uncertainties of expeditionary operations. The models can be run for a variety of mission requirements. This includes the support needed for different types of missions (for example, humanitarian, evacuation, or small-scale interdiction); effects on support system requirements of different weapon mixes for the same mission; the impact of different support policies, practices, and technologies; and other operation support needs.

The models have been designed to run quickly and estimate mission requirements at a level of detail appropriate for strategic decisions. This detail should include the number of people and large pieces of equipment that account for *most mission support airlift footprints*. It should also include enough detail so that major changes to support processes can be reflected in the model and evaluated against all metrics.

The final output of the modeling framework is an evaluation of the effects of each support option on spin-up time, airlift footprint, investment and recurring costs, risks, and flexibility. This shows the details of the trade-off between moving resources from centralized support locations or prepositioning them at FOLs.

ACS analyses may find that an option cannot be supported because of cost or process constraints. If so, then senior leaders can design an option with less cost or risk that would still achieve their goals. This framework thus can be used not only for ACS system analysis but also to support integrated analysis of operations, ACS, and mobility options.

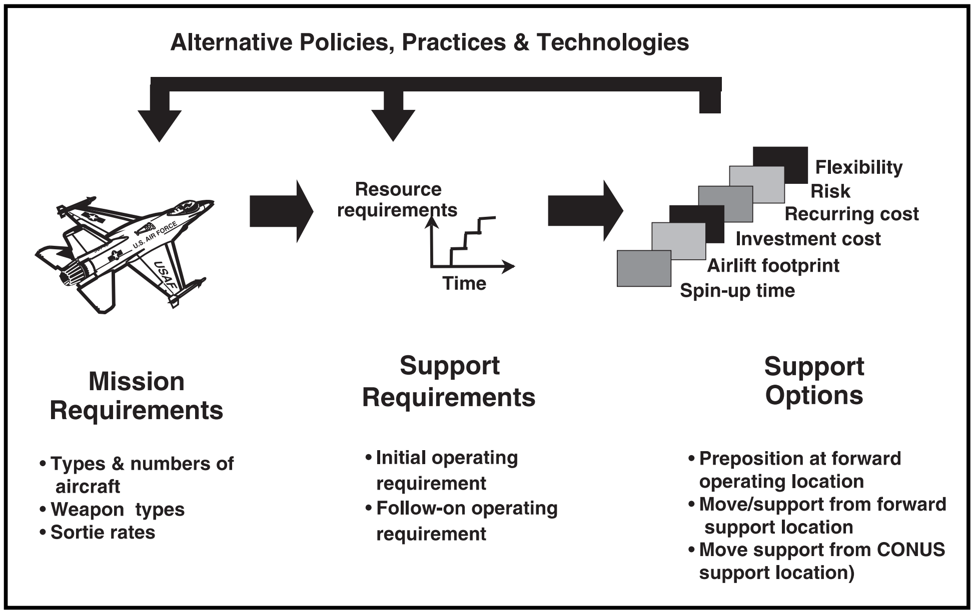


Figure 2. Employment-Driven Analytical Framework

Key Findings from ACS Modeling Research

Using an analytic framework and prototype models for some specific commodities has made clear the broad ACS system characteristics needed to support future expeditionary operations. An important finding of RAND/AFLMA research: the Air Force goal of deploying to an unprepared base and sustaining a nominal expeditionary force at a high operating tempo or a 36-ship package capable of air-defense suppression, air superiority, and ground attack aircraft cannot be met with current support processes. A 48-hour time line can be met only with judicious prepositioning and even then only under ideal conditions.

Table 1 shows the results generated from using a preliminary integrating model to minimize support costs and meet the employment time line while satisfying resource requirements for a 7-day surge employment scenario. These results were obtained by using inputs from our commodity models for munitions, fuel, vehicles, shelter, F-15 avionics components, and low-altitude navigation and targeting infrared for night (LANTIRN) needs for the 36-ship force.

A 48-hour time line requires substantial materiel to be prepositioned at the FOL. A bare base can be used only if the deployment time line is extended to 144 hours and substantial materiel is prepositioned at a regional forward support location—or FSL—and if intra- and intertheater transportation is available to move resources to the FOL.

The reason for this conclusion is simple: current support resources and processes are *heavy*. They are not designed for quick deployments to FOLs having limited space for unloading strategic airlift. Significant numbers of vehicles and materiel-handling equipment—such as forklifts and trailers—are required to meet EAF operational requirements. The airlift required to move this materiel, not including munitions, is enormous, and it may not always be available.

Shelter needs place another constraint on options for quick deployment. The current Harvest Falcon shelter package for bare

Time Line	Forward Operating Location	Forward Support Location	CONUS
Initiate & sustain at 48 hours	Bombs (IOR) Fuel Shelter Vehicles	Missiles (IOR & FOR) Bombs (FOR) Repair: F-15 avionics & LANTIRN	Unit equipment Two-level repair
Initiate & sustain at 48 hours	Bombs (IOR) Fuel Shelter Vehicles	Bombs (FOR) FMSE Repair: F-15 avionics & LANTIRN	Unit equipment Two-level repair Missiles (IOR &FOR)
Initiate & sustain ops at 144 hours	Fuel	Bombs (IOR &FOR) Repair: F-15 avionics & LANTIRN Shelter Vehicles	Unit equipment Two-level repair Missiles (IOR & FOR) Fuels Mobility Support Equipment

Table 1. ACS Modeling

bases requires approximately 100 C-141 (72 C-17) loads to move and almost 4 days to erect using a 150-man crew. The construction time for the Harvest Falcon shelter package alone means it must be prepositioned to meet a 48-hour time line or even a 96-hour time line.

These results do not mean expeditionary operations are not feasible. Technology and process changes may reduce the need to deploy heavy maintenance equipment. For now, however, these results do mean that setting up a strategic infrastructure to perform expeditionary operations involves a series of complicated trade-offs.

Expensive 48-hour bases may best be reserved for areas such as Europe or Southwest Asia (SWA), which are critical to US interests or are under serious threat. In other areas, a 144-hour response may be adequate. In still other areas, such as Central America, most operations will be humanitarian relief missions that could be deployed to a bare base within 48 hours since combat equipment would be unnecessary. For all these cases, the models and analytic framework being developed can help in negotiating the complex web of decisions.

One key parameter that affects ACS design is resupply time. If resupply time is cut, the initial operating requirements and initial deployment can also be cut. In addition to IOR, resupply time affects repair locations. If resupply time is long, more maintenance equipment and personnel must be deployed to keep units operating, and greater quantities of supplies will be needed to fill longer pipelines.

Short resupply times can help in dealing with uncertainties caused by an inability to predict requirements or by changes in requirements resulting from enemy actions. A short resupply time provides the ability to react quickly to inevitable surprises, mitigating their impact.

The future ACS system needs to be designed around expected wartime resupply times, not peacetime resupply possibilities. To examine its constraints, resupply time was analyzed as it varies by delivery process and assumptions. Parts of these data were gathered from actual delivery times. Others were generated with models, using optimistic assumptions, which help show differences between possible and actual system performance.

The left most curve in Figure 3 (Air Mobility Express–Commercial [AMX-C]) shows the distribution of best expected resupply times for small items (less than 150 pounds) that could be shipped via express carriers to SWA from CONUS. This distribution includes the entire resupply time, from requisition to receipt, and has a mean of about 4 days, including weekends, holidays, and pickup days. This distribution was generated from a simulation model using very optimistic times for each part of the resupply process. It assumes the processes are perfectly coordinated with no delays due to weather, mechanical problems, or enemy actions. This curve represents a current process optimum to SWA.

The third curve (Air Mobility Express–Military [AMX-M]) shows the expected distribution of best resupply times to SWA for AMX-M, the system used for large cargo in wartime, under optimistic assumptions. Median resupply time for this system is about 7 days. The fourth curve (SWA) shows the current actual delivery times for high-priority cargo to SWA units. These data include delivery times for both small and large cargo. Note that half these requisitions took more than 9 days to deliver.

Operation Noble Anvil (ONA) provided extensive evidence of this challenge. The second left most curve (ONA Worldwide Express [WWX]) shows the distribution of WWX deliveries during ONA. WWX is a Department of Defense (DoD) contract with commercial carriers to move small items within the CONUS and from the CONUS to the rest of the world. The contract specifies in-transit delivery times for shipments between specific locations. Most in-transit times to overseas theaters are about 3 days, but this excludes the day of pickup and weekends.

During ONA, the resupply times to Europe using WWX averaged about 5 days, while more than 10 percent of the deliveries took more than 10 days. As shown in Figure 3, the large items moved by military flights averaged more than 15 days to deliver.[6] Even in a highly developed theater, for a benign conflict environment, resupply times are lengthy.

The Department of Defense recently established a resupply goal of 5 days to overseas locations and ordered inventory levels to be reduced to reflect these new delivery goals. RAND/AFLMA research, however, indicates that a resupply goal of 5 days to overseas FOLs may not be achievable for small items in all wartime environments. Such a goal is probably not achievable for large items since the

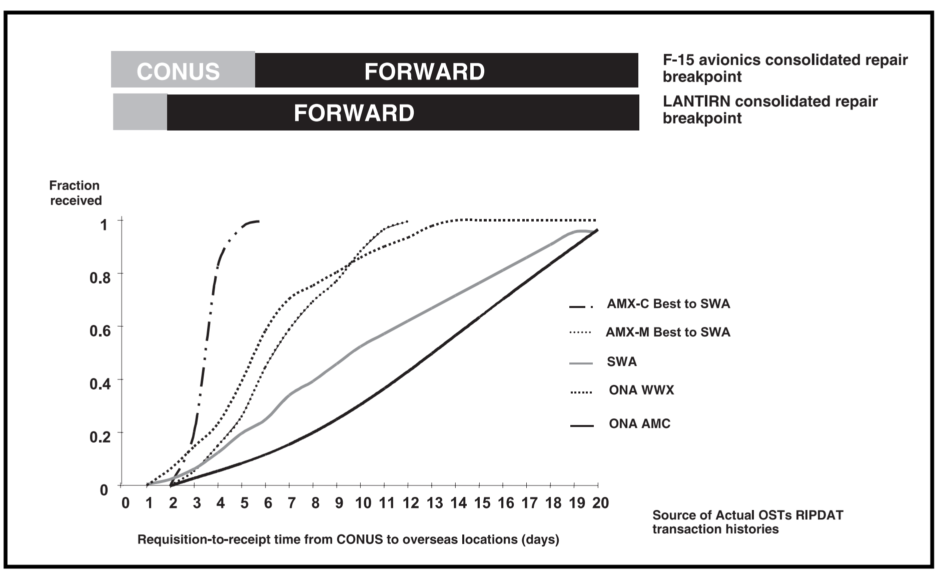


Figure 3. CONUS to SWA Resupply Times and Support Breakpoint Solutions

median of the expected delivery time distribution for such items under optimistic assumptions is 7 days.

As mentioned above, resupply time affects repair location decisions. Separate studies on maintenance support for key equipment in an expeditionary environment are being completed. For two cases in which the analysis is complete, F-15 avionics[7] and LANTIRN pod repairs,[8] the breakpoints for locating repair facilities in the CONUS or forward locations are shown at the top of Figure 3.

For F-15 avionics, consolidating repairs at regional or CONUS facilities sharply reduces personnel needs, as well as the need for some upgrades currently being considered for repair equipment. Resupply time for any consolidated repair facility, however, must be less than 6 days, or the longer pipeline will require substantial investments in new spare parts. Figure 3 shows that achieving such delivery times from the CONUS may be difficult, although data from theater support of mission capable (MICAP) requisitions indicates that transportation times from regional FSLs can meet the 6-day breakpoint.[9]

For LANTIRN targeting pods, for which no new acquisitions are planned, the breakpoint time line is even shorter because of the lack of spares. Maintaining the availability of working pods in an MTW requires transportation times of less than 2 days from a consolidated repair facility. Figure 3 shows that this is out of reach from the CONUS and it might even be difficult to achieve within theater. At the same time, however, deployment of LANTIRN repair to FOLs is not an attractive option. The test equipment is old, very heavy, and increasingly unreliable, so repair consolidation reducing the need for test equipment deployment may be required.

Models of individual support processes yield important insights for supporting processes for expeditionary operations. To plan an ACS system, outputs of models for different processes need to be integrated, and consideration should be given to the mixes of options. This may include a mix of prepositioning some materiel, deploying other materiel from FSLs, and deploying still other materiel from the CONUS. The research on this topic explores the use of optimization techniques to integrate options for several support processes.

From these analyses, it was concluded that performing expeditionary operations for the current force with current support processes and technologies requires judicious prepositioning of equipment and supplies at selected FOLs. This must be backed by a system of FSLs providing equipment and maintenance services. Such a system would require a transportation system linking FOLs and FSLs.

The Air Force already makes some use of FSLs, particularly for munitions and war reserve materiel (WRM) storage. Consolidated regional repair centers have also been established to support recent conflicts. During Desert Storm, C-130 engine maintenance was consolidated at Rhein Main AB, Germany. During ONA, intermediate F-15 avionics repair capabilities were established at Royal Air Force Lakenheath, United Kingdom.

Overview of a Global ACS System

Based on the preliminary results, an evolving ACS system to support expeditionary operations can be envisioned. The system would be global and have several elements based at forward positions or at least outside the CONUS. Figure 4 gives a notional picture.

The system has five components:

1. **FOLs**. Some bases in critical areas under high threat should have substantial equipment prepositioned for rapid deployments of heavy combat forces. Other more austere FOLs with longer spin-up times might augment these bases. Where conflict is not likely or humanitarian missions will be the norm, the FOLs might all be of this second, more austere form.
2. **FSLs**. The configurations and functions of these would depend on geographic locations, presence of threats, and the costs and benefits of using current facilities. Western and Central Europe are presently stable and secure; it may be possible from European FSLs to support operations in areas such as SWA or the Balkans.
3. **CONUS support locations**. CONUS depots are one type of CSL, as are contractor facilities. Other types of CSLs may be analogous to FSLs. Such support structures are needed to support CONUS forces, since some repair capability and other activities may be removed from units. These activities may be set up at major Air Force bases, convenient civilian transportation hubs, or Air Force or other defense repair depots.
4. **A transportation network connecting the FOLs and FSLs with each other and with the CONUS, including en route tanker support**. This is essential; FSLs need transportation links to support expeditionary forces. FSLs themselves could be transportation hubs.
5. **A logistics C2 system to organize transport and support activities and for swift reaction to changing circumstances**.

The actual configuration of these components depends on several elements. These include local infrastructure and force protection, political aspects (for example, access to bases and resources), and how site locations may affect alliances. The

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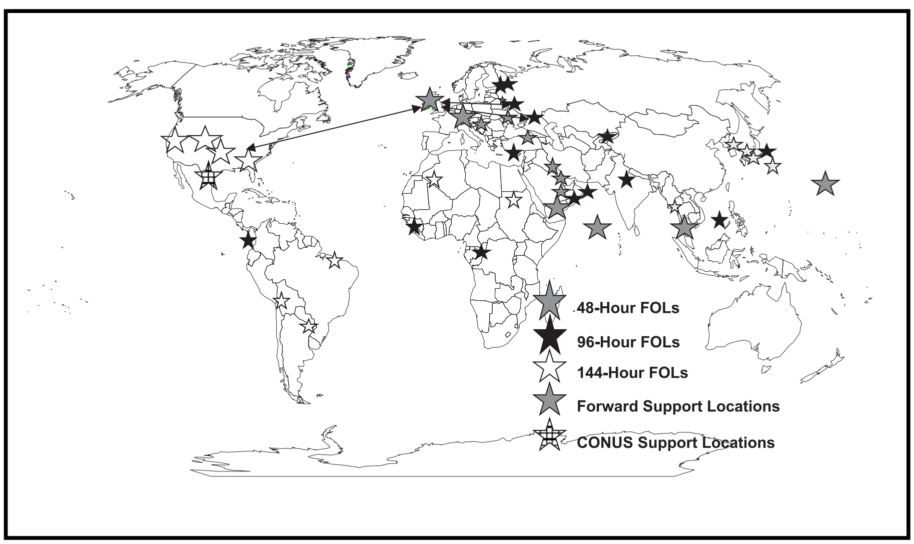

Figure 4. Potential Global ACS Network

AEF Munitions *Availability*

Lieutenant Colonel David K. Underwood

Captain John E. Bell

Professional logisticians must confront the challenges of a radically new environment as the United States Air Force transitions to an Expeditionary Aerospace Force (EAF). In addition to meeting ongoing commitments in Southwest Asia, the EAF concept is aimed at providing an effective military response anywhere in the world during the early stages of a crisis. Under this concept, airpower deploys within days or even hours in order to halt, fight, and eventually win a conflict. To implement the EAF concept, several difficult requirements must be met. First, the Air Force must be able to respond and sustain operations at austere or even bare base locations around the world within the first few days of a crisis or conflict. Next, the limited nature of available airlift to support deployment operations requires that any Air Expeditionary Force (AEF) remain as light and lean as possible. Third, the commander of a combatant command (CINC) expects Air Force elements to provide the capability to conduct precision attacks and to be able to sustain them for an indefinite period of time. To meet these rigid requirements, the Air Force must overcome the problem of transporting and providing thousands of short tons of munitions needed to support a combat AEF.

Worldwide Munitions Availability

During the Cold War, there was a fair amount of certainty about where we would fight the next war, and the munitions stocks at bases in Europe were expected to be used in place against the threat. However, with the EAF concept, there is no certainty about where we will conduct operations, and munitions at overseas locations may be as malpositioned as stocks in the continental United States (CONUS) at the onset of a conflict. Consequently, it will be an even larger challenge to get the right munitions to the right place, at the right time. A major requirement for AEF operations is standardized timing scenarios that support both rapid and effective planning. The AEF battle lab has performed much of the analysis in this area. Its timing scenario begins with some level of strategic warning, execution of orders within 24 hours, and bombs on target with 24 hours of notification. Other studies and documents, without qualification on the need for munitions prepositioning to meet actual or potential operational requirements, clearly note the need for bombs on target within 48 hours for the EAF concept to be credible.[1]

To understand the nature of moving and positioning munitions, we must first examine the current locations of munitions inventories around the world and the preparations made or planned to move these stocks in a crisis. Munitions positioning and transportation is set forth by the Global Asset Positioning (GAP) program as outlined in AFI 21-206, *The Global Asset Positioning Program*. GAP is a four-part system that includes Theater Munitions stocks, CONUS munitions stocks, Standard Air Munitions Packages (STAMP), and the Afloat Prepositioned Fleet (APF).

Theater Munitions stocks are already positioned at a handful of overseas locations. Their placement was dictated principally by past planning or operational requirements and less so by current requirements. The largest munitions storage area in the Air Force is at Kadena AB, Japan. It provides a large forward stock of munitions for the Pacific Air Forces (PACAF) and maintains a large munitions transportation capability known as the Tactical Air-munitions Rapid Response Package (TARRP) program. This program consists of 21 weapon-specific unit type code (UTC) packages, maintained by the 18th Munitions Squadron and available for rapid deployment in the theater.[2] In addition to Kadena, there are storage areas at Andersen AB, Guam, and on the Korean peninsula. In Europe, stockpiles at Camp Darby, Italy; Ramstein AB, Germany; Royal Air Force Fairford, United Kingdom; and the three fighter wings in the United States Air Forces in Europe (USAFE) provide munitions for European operations. At most of these primary storage locations, providing large shipments of munitions to other operating locations inside or outside the theater is a difficult process and not often practiced. However, under the AEF concept, it is likely the munitions flights at any of these locations will be tasked, often on short notice, to provide munitions for deployment bases or locations thousands of miles in advance of their own location. During Desert

Storm, when similar short-notice taskings to move munitions were generated, many problems were encountered. First, the required nets, chains, and 463L pallets required to move munitions were not always available and, in some cases, had to be flown into the shipping locations.[3] At other locations, the host nation required up to 30 days for approval to move munitions in the country, and access to critical port facilities needed for shipping was not guaranteed.[4] In addition, in today's Air Force, the average munitions specialist, Air Force specialty code 2WOXX, is not trained to prepare munitions packages for shipment on 463L pallets. The ability to rapidly move munitions will undoubtedly suffer from a large learning curve unless the unit or command implements its own policy and training prior to a crisis tasking. Finally, it should be remembered—and emphasized—that just because munitions stocks are available in a theater does not mean they are easily transitioned to a forward AEF location.

USAF munitions in the CONUS are usually located in large quantities at Air Combat Command bases with a bomber mission or stored at Army ordnance depots such as Blue Grass Army Depot, Kentucky; Tooele Army Depot, Utah; and Crane Army Depot, Indiana. The munitions at bomber bases are already tied to plan-tasked bomber flyaway missions and are not readily available for shipment to an AEF location. Also, Air Force munitions at Army depots have to be pulled from storage and shipped by ground or rail transportation to one of three munitions-explosive sited sealift ports in the CONUS. Their movement could easily take several weeks and is limited by the following: availability and speed of ground transportation for explosives, explosive storage at the ports, and availability of Military Sealift Command-contracted shipping to move the munitions from the CONUS. This movement process is not very responsive for meeting emerging expeditionary airpower requirements. The salient point is that CONUS-maintained stocks cannot be viewed as an unlimited source of supply for rapid movement to support expeditionary operations.

STAMP and APF Programs. Currently, the Air Force has a limited capability to provide munitions to support short-notice taskings. This capability is provided via the STAMP and APF programs. Both of these programs are managed by the Ogden Air Logistics Center (OO-ALC) and its USAF Ammunition Control Point. OO-ALC is responsible for identifying munitions availability and sourcing for the Air Force and supports requests for STAMP and APF munitions stocks as outlined in AFI 21-206. The STAMP assets are housed in two Air Force Materiel Command (AFMC) munitions storage areas, one at Lackland AFB, Medina Annex, Texas, and the other at Hill AFB, Utah. Together, these two storage areas have the ability to ship, by air, approximately 46 different types of munitions packages pre-identified as STAMP UTCs.[5] There is very little asset redundancy between the stocks at these two locations, and together they make up the STAMP program. The STAMP program is relatively small and has less than 100 total manpower billets. Of some significance, STAMP personnel provide the only Air Force training on how to prepare munitions for air transport using the 463L pallet system.

The Air Force currently stocks three prepositioning ships with Air Force munitions as part of the APF program. These ships—the *MV Buffalo Soldier, MV Major Bernard F. Fisher,* and *MV Captain Stephen L. Bennett*—are positioned to rapidly swing munitions to one of several theaters during a conflict. An afloat prepositioned ship (APS) brings a large—but limited—quantity of munitions to a theater and can fill the gap between initial starter stocks and resupply from the CONUS. The newest APS, the *MV Captain Stephen L. Bennett* and *MV Major Bernard F. Fisher* are container ships, and the Air Force intends to replace the *MV Buffalo Soldier* with a containerized vessel in FY01. Once this process is complete, the Air Force will have approximately 5,000 International Organization for Standardization containers loaded with munitions prepositioned at sea to support planned or operational demands.[6]

The Difficulty of Transporting Munitions

Munitions movement, regardless of the mode of transportation, is a cumbersome process. To compound this fact, munitions availability, particularly in large quantities, depends heavily on prepositioning and movement via sealift. During Operation Desert Storm, the majority of Air Force munitions assets moved by sea to the theater. In fact, according to a postwar report by AFMC, 326,000 short tons of Air Force munitions were transported by sea to Southwest Asia.[7] The transit time for sealifted munitions averaged 55-72 days after in port time and ground transportation to the deployed location.[8] By comparison, 26,000 short tons of munitions needed for Desert Storm were shipped by air using 693 C-141 (500 C-17) equivalent airlift missions.[9] This clearly illustrates that even hundreds of airlift missions can only lift a small percentage of the munitions needed for a large air campaign such as Desert Storm. In general, airlift of munitions, especially bomb bodies, to support combat operations is not efficient, since an average C-130 aircraft can haul only one munitions package. For example, a 2,000-pound, GBU-10, laser-guided bomb munitions package will max out the available space of a C-130 and provide only six weapons to the warfighter. The weight of the entire palletized package is well below the aircraft weight limit, but bomb bodies that overhang the 463L pallets and other tie-down considerations make this the maximum load for this weapon type on the C-130. At a rate of only six weapons per mission, the available airlift for munitions movement in a conflict is quickly consumed with only a handful of assets being delivered to the forward combat location in a timely manner. The ability of the airlift system to meet expeditionary timing requirements makes munitions prepositioning and shipment preplanning essential. This is true even if a significant amount of airlift is dedicated for initial movement and follow-on resupply. EAF operations will always be limited by the type and quantity of munitions available at the operational location.

Air transportation is not the only problem associated with munitions movement. In planning for the movement of containerized munitions via rail lines, the Services must be concerned about the maintenance and support of feeder rail lines to Department of Defense (DoD) sites with concentrated

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EXPLORING THE HEART OF LOGISTICS

Air Force Supply Requirements Team

Captain David A. Spencer

For years, the logistics community was unaware of the scope of the many disconnects that existed between logistics data systems. That is not to say no one knew there were problems with the generation of usage data, its transfer from retail to wholesale systems, and ultimately, its use in the wholesale world to determine spares requirements. Certainly, many were aware that this complex supply machine had some glitches. Indeed, groups such as the Air Force Materiel Command (AFMC) Requirements Interface Process Improvement Team (RIPIT) were successful in identifying and correcting bad data in wholesale systems. Even so, bad data tended to work back into databases. Most disconnects in the supply chain are caused by faulty or incomplete data transfers from one logistics data system to another. What caused these disconnects? Primarily, these problems came about as a result of changes made in policy and procedures in one system before the full impact of those changes on related systems could be assessed. Other causes include manipulation or changing data in one system before being passed to another. The scope and impact of the problem came about because few detailed comparisons were made between retail and wholesale supply usage data, and almost no examinations were done to identify and eliminate the *sources* of bad or dirty data. The result was a requirements determination for recoverable spares that was not optimized because the requirements computation sometimes used incomplete or inaccurate data.

In 1996, the Air Force Supply Executive Board (AFSEB) realized the need to link wholesale recoverable spares requirements determination with retail spares needs. This could only be done through centrally computing and *pushing* spares levels to retail supply accounts. Thus the Readiness-based Leveling system (RBL) was born. RBL is an algorithm, a mathematical means of allocating recoverable spares to minimize the number of back orders one would expect at any given time based on past usage (for more details on the function of the RBL model, see the summer 1999 issue of the *Journal of Logistics*). Data and the passing of data from the bases to AFMC have always been important to computing Air Force requirements. However, before RBL, the extent of the disconnected requirements data was not fully understood. With RBL, it became all too visible when the Air Force requirement—the number of spares AFMC bought and repaired—was sometimes insufficient to meet the needs of the bases. The reverse was also true, that bases had established requisitioning objectives higher than their actual need, thus contributing to a maldistribution of assets. Implementing the AFSEB decision to centrally compute levels would require the coordination of logistics personnel from all parts of the supply chain in order to make the systems and procedural changes necessary to get RBL functioning. During RBL implementation, an informal team came together initially to work issues, but as time passed, it became apparent that a number of disconnects existed in the data systems. Therefore, the AFSEB decided to create and staff a permanent team. In the words of the 1997 AFSEB-approved Air Force Logistics Management Agency (AFLMA) *Requirements Team Study*, in which the formation of a team was recommended:

> Previous Air Force analysis results and initial attempts to implement Readiness-based Leveling, highlighted the relatively poor condition of Air Force systems that provide data to the requirements systems—those systems that compute buy and repair requirements and prioritize assets for repair, distribution, and redistribution of assets. In order to successfully implement RBL, the Air Force had to improve the data collection and transmission process, build an accurate database, and put in place mechanisms to identify and correct inaccurate data. The Air Force did manage to successfully implement RBL, but it took a concentrated Air Force-wide effort led by something akin to an Air Force Requirements Team. A partnership of the Air Force Logistics Management Agency (AFLMA), Headquarters Air Force Materiel Command (HQ AFMC) LGI and SAO/XPS, and Standard Systems Group (SSG), along with MAJCOMs [major command] and Air Logistic Center (ALC) RBL points of contact improved the RBL database sufficiently for implementation.

When the AFSEB accepted the recommendations of the study, it also approved a charter—soon to be included in Air Force Manual 23-110, *Basic USAF Supply Manual*—detailing the work that lay ahead for the new team and assigning specific responsibilities to its members. These responsibilities include testing databases to measure, identify, and correct inaccurate data; developing, collecting, and analyzing requirements performance data; analyzing alternative policies and systemic problems; providing recommendations for improvement; and monitoring RBL to include analysis of quarterly computations, resolution of problem items, and out-of-cycle RBL computations in support of contingency operations. The Requirements Team is charged by the AFSEB with examining the data and processes used to compute retail and wholesale stock requirements for reparable assets, allocating levels, distributing and redistributing these assets, and prioritizing repair resources. In other words, the Requirements Team is responsible for monitoring and improving the health of the requirements systems and processes as well as running the RBL model. Managing reparable asset level allocation for $8B of spares involves working with and monitoring various systems, including the Standard Base Supply System (SBSS), the D035 Stock Control Systems that collect and pass usage data, and the DO41 Recoverable Consumption Item Requirements System, which computes the worldwide recoverable spares requirement.

Who makes up the Requirements Team? Both military and civilians are a part of the team. Every MAJCOM, each ALC, and the SSG have points of contact matrixed into the team who provide field level perspectives, assistance during RBL computations, and expertise that is critical to improving the Air Force requirements system. There are four permanent positions dedicated to the mission of the team. Two of those billets, one officer and one senior noncommissioned officer (NCO), are located at HQ AFMC. They work closely with the AFMC D035E RBL system functional manager and have the opportunity to interact with all the other AFMC system functional managers. In addition, they are able to call on the resources of the AFMC Studies and Analysis Office to help tackle some of the most difficult problems. However, some problems require more extensive research. This is where the other two members of the team come into the picture. Assigned to the AFLMA, one officer and senior NCO lead comprehensive studies and provide analyses on the Air Force requirements system. They also conduct detailed analyses of databases and data transfers. All four members of the team report to the chief of the Item Management Division at HQ AFMC.

The Requirements Team has quite a task, but thanks to the expertise and dedication of all the members, both permanent and matrixed, it is a task that so far has been manageable. Indeed, the team has enjoyed numerous successes since its inception. These successes came about as the result of two primary activities: scrutinizing data used to compute and allocate requirements and designing improvements to the requirements system.

Problem Item Reduction

A primary focus of the Requirements Team is the reduction in RBL-identified problem items. These are national stock numbers (NSN) for which the DO41 computed spares requirement is insufficient to meet base and/or depot needs. The problem items are categorized according to the severity of impact on users and/or failure to meet an established policy. The following are the different types of RBL problem items:

***N* (Nonpushed) Item**. The expected pipeline is greater than the requirement plus two and the expected system back orders (EBO) are greater than two. The system EBO is the number of back orders one can expect to exist at any given point in time.

***Z* (Zero Requirement) Item**. The requirement is equal to zero, yet the projected D041 pipeline is greater than zero.

***A* (Adjusted Stock Level) Item**. The sum of the adjusted stock levels (ASL) is greater than the requirement.

***H* (Heuristic) Item**. The expected pipeline is greater than the requirement and the EBOs are greater than one.

***T* (Trivial) Item**. The expected pipeline is greater than the requirement, and EBOs are less than one.

***I* (Initial Spares Support List [ISSL]) Item**. The requirement is less than the sum of actual demand, ASLs, and ISSL levels

*** Item.** The requirement is insufficient to meet the communications electronics (CE) policy of placing two levels at the depot after filling base ASLs.

***Y* Item.** The requirement is insufficient to meet the CE policy of placing two levels at the depot. Unlike the * items, there is no base need for these (demands or ASLs).

The team developed a listing of these problem items, ranked in order of type and severity, for use by the ALC item manager (IM) during quarterly DO41 file maintenance. The listing ranks the problem items in order of severity (as listed above) and provides an individual list for each IM at each ALC. It also provides key data that the IM can use to find the causes of the disconnect and, if appropriate, adjust D041 data such that it will compute a more accurate requirement. This tool was instrumental in helping the IMs resolve more than 5,400—or 75 percent—of the most severe problems (N and Z items). It not only provides a comprehensive list of NSNs where the requirement is insufficient but also prioritizes the list, enabling the IMs to focus their efforts for the greatest gain. Table 1 illustrates the substantial progress made to date by the IMs. Even more encouraging is that the sources of these problem items (for example, failure data not reaching the DO41 database) are being eliminated. In October 1999, the Air Force brought on line a new method of reporting failure data that will ensure full reporting of failure data and ultimately allow nearly complete resolution of these types of problem items.

Table 1 displays the success AFMC and the Requirements Team have had eliminating problem items. Overall, problem items have decreased by 56 percent since RBL's inception. Only two categories experienced an increase. The increase in T items resulted from an incomplete resolution of the more severe H items requirement for these NSNs but not enough to completely fill the pipeline, causing them to shift to a less severe category. The increase in Y items is a result of improvements in communications electronics spares policy and should decrease rapidly over the course of the next few months as the policy changes take full effect. The Requirements Team will continue to work the issue of problem item reduction on a quarterly basis through analysis at the AFLMA and providing problem item lists to all IMs. The efforts of the team will provide IMs with the assistance they need to improve spares support for base-level customers.

Data Comparisons

Quarterly, the team makes data comparisons to identify potential problems within the requirements system. Data from the Standard

Type Problem Item	Number Existing when First Defined*	Number Existing as of Oct 99	Numerical Change	% Change
N	854	706	- 148	17
Z	6,484	1,184	- 5,300	82
A	2,560	2,217	- 343	13
H	1,637	441	- 1,196	73
T	525	837	+ 312	59
*	16,732	5,540	- 11,192	67
Y	8,788	10,417	+ 1,629	19
I	1,467	599	- 868	59
TOTAL	39,047	21,941	- 17,106	56

* Not all problem items had been defined as of RBL's inception in April 1997. Some were defined and incorporated into the model more recently.

Table 1. Readinesss-based Leveling Problem Item History

Base Supply System, DO35K Depot Retail Supply Accounts, and DO41 are gathered by the AFLMA and run through a suite of locally developed software programs that compares base to wholesale data and conducts analyses of the data. First, the team examines demographic data such as the number of records compared to previous quarters, number of ASLs, and the worldwide base and depot requirement compared to previous quarters. Demand and pipeline data are examined to identify changes requiring further investigation. These include repair cycle times for base and depot, daily demand rates, percent base repair, order and ship time, and report dates when SBSS accounts last provided data to DO35, among others. Verifying that these values remain within certain parameters indicates the requirements computation and asset level allocation have accurate data with which to work. Then, more detailed analyses take place. The team performs a thorough review of problem items and runs a comparison between RBL and repair cycle demand levels to ensure that the distribution of RBLs is occurring as intended. Also generated is a summary for each Air Force stock record account number (base-level supply accounts) detailing the impact of problem items and cases where levels provided were insufficient to meet their needs.

These data analyses, along with many others performed by the team, have identified and led to the resolution of numerous problems. Some of these problems include incorrect reporting of order and ship time and daily demand rate by the SBSS, a limit on the number of images per transaction in the Defense Automated Addressing System that prevented some base-level transactions from being received by DO35, an error in the number of user data passed to DO41 that affected safety levels, and sudden decreases and omissions in requirement. These are only a sample of the errors discovered by members of the Requirements Team, and in a complex system such as ours, more will certainly be discovered. But as the number of analyses performed by the team increases over time, problems solved, and improvements implemented, the disconnects should decrease in number and severity. Certainly, the primary goal of the team is to expand the breadth and detail of their analyses so as to identify and assist the resolution of more system disconnects.

Contingency High-Priority Mission Support Kits

A Contingency High-Priority Mission Support Kit (CHPMSK) is a newly implemented concept that accomplishes two purposes. First, it replaces the old unfunded High-Priority Mission Support Kits (HPMSK) that were built to support the Gulf War. The reason for replacing unfunded HPMSKs with CHPMSKs is to ensure that kit levels generated are included in the Air Force requirements computation so that the levels are supportable. (Developing an HPMSK for a contingency using current procedures would require a lead time to include its levels in the requirements computation. A CHPMSK can be built in a few days, and its levels are already supported by the computation.) Second, it presents an opportunity to use peacetime operating stock (POS) spares to support a deployment exceeding 90 days. Temporary High-Priority Mission Support Kits should be used for shorter deployments because they do not require an RBL recomputation each time. When computations are run too close together, a great deal of instability in worldwide levels is introduced. The additional POS support is needed for less than full squadron deployments when a unit's Readiness Spares Package (RSP) is insufficient to meet the contingency mission capable goals. CHPMSKs are computed using the Aircraft Sustainability Model (ASM) to determine the range and depth necessary to achieve a given weapon system availability target. Once any RSP being used as support is subtracted from the ASM output, the CHPMSK is tailored, with Requirements Team assistance, to provide maximum support while minimizing impact on the requirements system as a whole. This entails assessing the impact of the kit on worldwide EBOs and/or other bases that use the spares. All CHPMSKs require Air Staff approval to load, are designed to receive a high-priority refill, and can be given a project code if certain criteria, as decided by Air Staff, are met. The kit itself is loaded at HQ AFMC as special levels in the RBL database and as specially coded HPMSK levels in the SBSS at the deployed location. This facilitates management (transfer, reconciliation, and deletion) of the kits and allows easy alterations as needed. The special levels loaded into the RBL database are not passed to the DO41 requirements system as additional requirement.

Recently, the Requirements Team, working in conjunction with United States Air Forces in Europe, helped develop and load ten CHPMSKs, containing more than $30M of spares, to augment RSPs for units deploying in support of Kosovo operations (Operation Noble Anvil). These kits, loaded as an out-of-cycle RBL computation, directly contributed to higher aircraft availability rates for several Mission Design Series (MDS) during the contingency. Other CHPMSKs currently loaded include kits in support of Operations Full, Northern Watch, and Southern Watch.

Communications Electronics Spares Allocation

Communication electronics spares are low-density spares used on communications and other high-reliability systems managed by the Air Force Communications Agency (AFCA). These spares support systems, such as communications equipment and radar, must remain operational with the least possible down time. The low numbers of these spares combined with the criticality of the systems supported posed a special problem: how should levels for these spares be allocated to maximize system availability? Working with AFCA, the Requirements Team developed a regionalization policy for these spares. First, these spares were divided into two classes, either single point failure (SPF) or nonsingle point failure (NSPF). Single point failure items are those that support systems that cannot be inoperable for more than 48 hours; the remainder comprised NSPF items. The AFSEB approved a recommendation to institute the following regionalization policy: stock SPF items at every base and have a minimum of two serviceable spares at the depot; for NSPF, stock only at bases with three or more demands and have a minimum of one serviceable and one unserviceable spare at the depot. This would enable the depots to rapidly replace used spares at the retail level and induct parts into repair. The two serviceable spares at the depot are meant to ensure supply support within 48 hours. For critical systems, those supported by SPF spares, operating locations were allowed an AFCA approved ASL to ensure serviceable spares would be on hand in the event of a failure. Once a failure occurred, the base would send the unserviceable carcass back to the depot, and the depot would release another serviceable spare to fill the hole now existing on the base's shelf.

Once this policy was in effect, AFCA and its sponsored Communications Electronics Working Group began to review the way in which allocations of CE items are made. AFCA developed a centralized means of managing allocation of CE spares. Instead of simply approving or disapproving ASLs, AFCA built a database comprising all CE spares levels. This database currently serves as the source for an input file, used by AFMC, to input CE ASLs into the RBL database. Each quarter, an updated AFCA database is used to create a new input file. The levels in this input file overlay the levels resident in the RBL database, with few exceptions for common use items, thus not only ensuring that CE levels worldwide are current but also keeping the RBL database current. Once the October 1999 RBL push is completed, AFCA plans to direct the deletion of all CE ASLs at retail supply accounts, completing the transfer to centralized management of these levels. The benefit will be greatly improved accuracy in this major portion of the ASL database and greater flexibility in support. Finally, the AFLMA is reviewing the CE spares policy to determine if further cost savings can be achieved by making adjustments in the regionalization rules.

AMC FSL Spares Allocation

Until April 1999, the Air Mobility Command (AMC) used its own method of computing spares levels for its FSL (forward support location) accounts. These FSL accounts provide logistics support to AMC en route strategic airlift aircraft (C-5, C-17, and C-141). Therefore, it is critical to have the right mix of spares on hand at each account in order to prevent grounding an aircraft while it is en route. The AMC method of level computation worked well enough, but a mismatch existed between forward supply location (FSL) needs and the worldwide requirement. Thus, the Air Force requirement was insufficient to meet the FSL levels. The AFLMA agreed to study the process and decide whether or not it could be improved. The AFLMA report *Forward Supply System–Forward Supply Locations Data and Requirements Pass* recommended studying the AMC computational method and including FSL leveling in the RBL system. The follow-on reports, *Forward Supply System—Forward Supply Locations Inventory Policy Review* and *AMC's FSS Leveling Policy—How to Include in the Air Force Requirements System* developed an improved leveling policy and provided recommendations on how the new policy should be integrated into the requirements system. Once approved by AMC and the AFSEB, the Requirements Team and AFMC took these recommendations and, in conjunction with HQ AMC Supply personnel, developed procedures for the new FSL computation. This new FSL computation was fully implemented in the July 1999 RBL computation and ultimately cut stockage costs by $9.54M, increased aircraft availability 4.6 percent, yet provided an additional 1,500 levels to these accounts. More important, the FSL levels will be included in the Air Force requirement since DO35E (the RBL database) passes the FSL requirement directly to DO41.

Adjusted Stock Level Process and Data Improvements

The Air Force has been concerned with the number of adjusted stock levels because data suggests that increasing ASLs decreases overall spares support. Therefore, it is critical to ensure that ASLs are accurate and necessary. Over the years, more than 98,000 ASLs accumulated in the DO35E RBL database. With such a large number, one would automatically expect some portion to be suspect. Indeed, many levels were caused by dirty data; the ASLs had been deleted at base level but never deleted from the AFMC database due to failures in the transmission process. Prior to the implementation of RBL, the Requirements Team reviewed the ASL database and immediately identified almost 20,000 ASLs for deletion, either because of dirty data or the bases determined that the levels were no longer needed. Since then, identifying suspect ASLs has required a more systemic approach. First, the team focused on problem items that had ASL levels. Next, a comparison between levels at various retail locations was made. Any levels that greatly exceeded the next highest base ASL were identified as being suspect and passed to the MAJCOMs for review. As a result of this process, the team achieved a reduction in the total number of ASLs in the RBL database to 71,362, representing a 27 percent decrease in ASLs since inception of RBL.

Another problem with base-initiated ASLs was the approval process. The IM community did not have an established quantitative means of determining whether or not to approve a proposed ASL. In the interest of building a standardized process that took into account the impact of approving ASLs on the requirements system, as well as providing automated assistance to the IM, the Requirements Team developed a software tool to analyze base-submitted ASLs. This tool takes into account many factors—including unit price, asset position, and the size of the level requested—in order to give the IM a recommendation as to whether or not the level should be approved and loaded. The tool was included in the DO35E system to make it convenient for IM use. Training in use of the tool is currently underway. When training is complete, the IM community will be ready to put this tool to use as soon as the base-initiated ASL moratorium is lifted.

Forward-looking RBL

Forward-looking RBL is a centralized means of effecting a mission change. A mission change occurs when a unit or a portion of a unit moves from one location to another and requires POS for spares support. There are two types of mission change, either permanent or temporary. A permanent change takes place when a weapon system moves from one location to another. A temporary mission change—or deployment—is a short-term move from a permanent base to an operating location until either a specific mission is accomplished or responsibility for that mission is passed to another unit at which point the weapon system returns to its permanent base. Forward-looking RBL is designed to transfer the established spares demand from the previous base to the operating location or new permanent base and establish stock levels at the new location.

Forward-looking RBL accomplishes several things. First, it ensures that adequate POS levels are available for temporary mission changes. Second, it reduces the POS levels at the home station by a multiplier derived from the percentage of home station aircraft that are deploying. This has the effect of ensuring the home base does not continue to requisition assets for which it has no need. It also maintains the sum of worldwide levels such that they do not exceed the DO41 worldwide recoverable spares requirement so that the POS levels at the deployed site—and everywhere else—are supportable. Third, it is a centralized process that is easy to manage and can be quickly implemented in case of a sudden contingency operation. And it does not require any expertise or management on the part of base-level personnel. Last, it provides the most accurate forecast of future demands because it transfers demand data specific to the moving unit.

The Requirements Team is in the final stages of implementing forward-looking RBL. SSG has prepared all necessary SBSS changes, and usage procedures are in place. Soon after the DO35E portion of the Stock Control System technical refresh is completed in June 2000, AFMC expects to bring this powerful tool on line. Specifically, how will it function? The summary below, taken from the Air Force Logistics Management Agency report *Forward-looking Readiness-based Leveling* illustrates how the data is manipulated and transferred to the new location.

> For forward-looking RBL, the gaining MAJCOM must determine a multiplier to effect the mission change. Using the example from the report, 18 of 54 aircraft at the home base were permanently moving to the gaining base. Assume the 18 aircraft moving to the gaining base are a different MDS than the aircraft already at the gaining base (no common use items between the two MDSs). Also assume the home base had experienced three demands per quarter for the last four quarters (a Daily Demand Rate or DDR of 0.03). The application of forward-looking RBL would be:

	Home Base	Gaining Base
Original Demand Data (DDR)	0.033	0.000
Prorated Demand Data	0.033*36/54	0.033*18/54
New Base DDR	0.022	0.011

Table 2. Forward-looking RBL DDR Computation

> RBL will prorate the demand data so the new home base DDR would be 0.022 and 0.011 for the gaining base. Now, forward-looking RBL is designed so that after 1 year each base's RBL will be based on what it is actually experiencing and not the prorated data. Table 3 illustrates this procedure for the home base.

Home Base (Prorated DDR=0.02)	Calculations	Final DDR for RBL
1st Quarter (Actual DDR=0.03)	(0.022*0.75) + (0.03*0.25)	DDR = 0.025
2d Quarter (Actual DDR=0.027)	(0.022*0.50) + (0.027*0.50)	DDR = 0.025
3d Quarter (Actual DDR=0.025)	(0.022*0.25) + (0.025*0.75)	DDR = 0.024
4th Quarter (Actual DDR=0.022)	(0.022*0.0) + (0.022*1.0)	DDR = 0.022
Note: RBL weights the actual data in 0.25 increments until the end of the fourth quarter when all data is based on actual demands. This same pro cedure would apply to the gaining base as well.		

Table 3. Home Base Prorated DDR Computation

For our previous example, we assumed that there were no common items between the home base and gaining base. What happens if the mission change involves common items (same MDS)? Assume that the gaining base already has 54 of the aircraft assigned and the 18 aircraft from the home base brings the total

Gaining Base (Prorated DDR=0.01)	Calculations	Final DDR for RBL
1st Quarter (Actual DDR=0.005)	(0.01*0.75) + (0.005*0.25)	DDR = 0.015
2d Quarter (Actual DDR=0.011)	(0.01*0.50) + (0.011*0.50)	DDR = 0.013
3d Quarter (Actual DDR=0.011)	(0.01*0.25) + (0.011*0.75)	DDR = 0.011
4th Quarter (Actual DDR=0.011)	(0.01*0.0) + (0.011*1.0)	DDR = 0.011

Table 4. Gaining Base Prorated DDR Computation

to 72 aircraft. Also, assume that the DDR for the gaining base is 0.05 for the 54 aircraft. The original mission change at home station would remain the same since the 18 aircraft are still leaving the base. To account for the increase in aircraft at the gaining base, make the following adjustments in RBL:

Gaining Original DDR	= 0.05
Home Base Prorated DDR	= 0.01
New gaining base DDR	= 0.05 + 0.01 = 0.06

The new gaining base prorated DDR would be phased out in four quarters, similar to the previous example.

Current and Future Team Projects

In addition to the regular tasks of resolving requirements system problems and consulting on requirements issues, the team has a number of projects currently under way. One involves resolving problems with ISSL levels. Identified by RBL, this problem is the result of insufficient DO41-calculated requirement to support both actual demand and established ISSL levels. Although not yet complete, this study already identified some areas of improvement in the ISSL management process and resulted in a 50 percent reduction in the number of ISSL-caused problem items.

Another project is concerned with a fluctuation of base-level requisitioning objectives (RO) as reported to the Execution and Prioritization Repair Support System (EXPRESS). If the base RO changes too frequently, EXPRESS has difficulty prioritizing assets for repair. The Requirements Team is working to trace the sources of the fluctuating RO and develop a means to ensure the correct RO gets reported to EXPRESS in a more usable manner.

Also in work is a project studying the changes in RBL over time. Some of the RBLs that change every quarter do so without significant impact on expected back orders. That is, a base level is reallocated from one base to another for a very small (less than 0.001) expected back order reduction. The team is developing a means of identifying and smoothing these levels to eliminate a level change and potential asset movement unless there is a significant positive impact.

In the future, the team plans a more systematic review of data transfers between systems, including building analysis software and metrics to measure the accuracy and consistency of all the data used by the systems. An example of a data review that the team will soon undertake is a comparison between base-level data, DO35C data, and the data fed to EXPRESS to verify that EXPRESS is receiving correct information. It was recently noted that the requisitioning objective passed to EXPRESS fluctuates. The Requirements Team decided that the primary source of that fluctuation is RSP levels and plans to compare base RSP levels to the levels AFMC inputs to the requirements system and uses to prioritize repair requirements. In addition, the Air Force Directorate of Supply tasked the AFLMA to develop additional supply data metrics. By virtue of the data comparisons, the Requirements Team will play a role in concluding that project. The metrics project will almost certainly lead to further examination of requirements data and more improvements in the accuracy of logistics data. For a more complete list of Requirements Team projects currently in work and pending, visit the RBL web site at http://www.afmc-mil.wpafb.af.mil/HQ-AFMC/LG/lgi-page/rblwebsite/ or the Requirements Team web site at http://www.afmc-mil.wpafb.af.mil/HQ-AFMC/LG/lgi-page/D035/reqsteam.htm.

Conclusion

So what can the Requirements Team do for you? To begin with, it serves as an information clearinghouse. Reports published by the team are maintained on the AFLMA web site under the Supply Division. Also, members of the team serve on various working groups and integrated process teams throughout the Air Force, which makes the team a good place to start looking for answers to requirements related questions. Another function of the team is problem identification. Problems experienced in the field or at the ALCs and identified to the team often lead to improvements in the system, so they welcome suggestions and input. Finally, the team works to resolve various issues raised by the Air Staff and MAJCOMs, issues that will impact how we all do business in the requirements system.

The AFSEB recognized the need for a permanent team to monitor and improve the health of the requirements system and directed the formation of the Air Force Requirements Team. The team strives to further improve methods of collecting and using logistics data, improvements that will have a direct and positive impact on the warfighter. Team efforts to further reduce problem items will lead to fewer back orders and a higher percentage of filled levels. Work to eliminate the ISSL disconnects will further increase the number of levels available for base support. Identifying and deleting unnecessary ASLs will also increase levels available for bases with actual demand. Analyzing data and its transmission will ensure that the requirements computation and EXPRESS execution is based on accurate data. For further information on the Air Force Requirements Team, visit the RBL and Requirements Team web sites, which have links to more information, reports, and a list of RBL organizational points of contact.

Captain Spencer is assigned to the Requirements Team and is a project manager in the Supply Division of the Air Force Logistics Management Agency.

Reengineered Supply Support Program

Technical Sergeant Debra Richerson

During the Cold War, policy makers decided that it was necessary to accept enormous resource investments and potential waste when the perceived enemy threat was high. We needed to field fully capable weapon systems as fast as possible as a form of deterrence and to keep ahead of our adversaries. The Cold War is over, and as the threat of global combat decreases, the Services are challenged to look closely at how the supply chain is managed so we can best utilize scarce resources.

In 1994, Headquarters, Air Force Materiel Command (AFMC) formed a team to review current business practices and issues concerning the way the Air Force buys initial spares for weapon systems. As a result, the Reengineered Supply Support Program (RSSP) was born. The Assistant Secretary of the Air Force, Acquisition (SAF/AQ); Deputy Chief of Staff, Installations and Logistics; and the Air Force Materiel Command/DR/LG endorsed the RSSP concepts. Four pilot program weapon systems were implemented in May 1997. Efforts were focused on developing ways to integrate preoperational, interim contractor support and initial spares requirements into a seamless support network.

What is RSSP?

RSSP is a reengineering effort designed to form a partnership between government and industry that streamlines the weapon system spares acquisition process. The partnership allows total asset visibility of contractor spares actions resulting in demand-based acquisitions, minimal excess, increased support, and improved acquisition techniques.

RSSP will use more reliable logistics and program data resulting in optimum investment of available resources. Actual usage and failure data is recorded from the beginning of the acquisition process. This data is used to make demand-based procurements and eliminate disconnects between faulty spares computation logic, budget estimates, and actual executable requirements.

The key to a program's success in implementing RSSP tenets is establishment of a weapon system Supply Support Integrated Product Team (SSIPT). The SSIPT is formed early in the acquisition cycle and involves a partnership between government and industry functional experts. The SSIPT will define the support requirements for the Interim Supply Support (ISS) period.

The ISS is a period of time between operational turnover of a weapon system to the user and establishing an inventory control point. The contractor will be the source of supply for the peculiar items associated with the new weapon system and will be responsible for managing the inventory and repairing or replacing the items. The contractor will provide sufficient assets to support system requirements/operational goals. The contractor will also provide visibility and access to the needed data by interfacing with standard Air Force systems where feasible and cost effective. The SSIPT and the responsible supply and maintenance personnel will have access to the data. If a non-Air Force system is used, then the contractor will ensure visibility and access to the data by adhering to the Global Combat Support System (GCSS) architecture and data standards. Contractor performance during ISS will be evaluated based upon stockage effectiveness, mission capable (MICAP) fill rates and other similar performance measures.

Common items, known as government-furnished material, already stocklisted and managed within the government inventory will not be included as part of the contractor's responsibility during the ISS period but will be managed through the normal supply chain as they are today.

When contracting for the ISS period, the contract must be written so that the efforts associated with the management of the items (for example, supply management, inventory control, and procurement) and those associated with the maintenance, repair, or replacement of the items are tracked on different contract line item numbers. This allows proper reporting of maintenance and repair actions under Title 10, USC 2466. Funding for the management of the ISS period, as well as contractor repairs and maintenance, will be with appropriate 3010, 3020, and 3080 procurement funds.

The ISS period will end after the weapon system program transitions to an inventory control point (ICP) for support. This will entail the procurement and delivery of the required spares, failure information, and technical data. If the decision is made by the system program director, with coordination of the major commands (MAJCOM), not to transition to an ICP, then the ISS period will end, and a logistics support contract will replace it.

Why Is RSSP Needed?

Years of inaccurate forecasting resulted in purchasing the wrong spares often too early in the acquisition process. In the past, both the contractor and the government used mathematical models to forecast spares, but they rarely shared the data. The government estimated what they thought was needed and bought it. The old process did not allow for estimates based on actual demands. The government bought spares for an unstable system design or based on faulty forecasting models, thus creating a huge surplus of unused and/or obsolete inventory.

Seven General Accounting Office and Air Force Audit Agency audits conducted between 1985 and 1994 documented the current methodology of acquiring spares as inadequate. Those audits alone computed excess spares at more than $2.8B. The audits pinpointed several reasons for excessive spares to include erroneous estimates, duplicate buys, and buying spares for an unstable design. The Defense Logistics Agency (DLA) also conducted studies on the supply support request process and found similar problems with stocking the wrong assets and low or nonexistent demand on parts.

What Will RSSP Do?

The RSSP concept is designed to save initial spares dollars by acquiring the *righ*t spares to support weapon system requirements (for example, right configuration, price, and quantities). The new process will provide the much needed common point of reference throughout the acquisition phases and even into the sustainment phase.

The reengineered process relies heavily on an automated data exchange capability that will allow the capture of spares usage and failure data during the early acquisition stages of a weapon system. The SSIPT and the MAJCOM will use the data exchange information to determine if and when to transition the weapon system to an ICP for sustainment. They will also use the information to determine which spares should be bought, what quantity, and price to provide the necessary supply support. From the warfighter vantage, the data exchange will provide spares asset visibility back through existing wholesale and retail systems to the contractor inventory. To provide this online visibility, the RSSP data exchange will link to and become an integral part of the current integrated logistics efforts under the GCSS-AF umbrella.

Under RSSP, contractor performance is assessed prior to transition. Contractors will be obligated to perform spares support at the government's stated levels or risk forfeiture of an award fee or profit. Contractors are tasked with identifying unique spares, initiating cataloging actions prior to fielding the weapon system, and recording consumption data for assets already cataloged. This will ensure retail level users can operate their requisitioning process as it is done today. Additionally, the entire transition process will be seamless to the retail supply account and maintenance functions at base level.

RSSP will change the spares acquisition financial process and move away from using multiple funding sources to purchase equipment or modifications, initial spares, and associated documentation. The new concept will finance key aspects using a single funding source within the equipment or modification line in the database.

Where Are We Now?

RSSP is the number one sponsored program for the Aerospace Industries Association. Two project offices oversee the day-to-day RSSP implementation strategies of four weapons system activity teams (WSAT) and nine core activity teams (CAT).

The nine CATs responsible for implementation include AFMC policy, retail supply policy, DLA policy and systems, personnel, training, data model enhancements, financial concepts, data exchange, and procurement concepts. The four WSAT pilot programs (Spacelift Range Systems, C-17, F-22, and C-130J) bring unique RSSP challenges. Each of the programs is in a different stage of the acquisition cycle. The four pilot programs played an active role in the reengineering effort during the concept development and planning phase and will continue to do so during implementation.

In a nutshell, RSSP will increase total asset visibility to the warfighter by using a data exchange system that reaches back to the contractor. It will provide the opportunity to make demand-based acquisitions and not purchase solely on estimates, and it will simplify the financial process. But most important, it will improve spares support to the warfighter while reducing life-cycle costs.

For more information about RSSP and team points of contact, see the RSSP web site: www.cisf.af.mil/rssp.

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> *Logistics must be simple—everyone thinks they're an expert.*
>
> —Anonymous

Planning Module

MAURICE W. CARTER

RONALD W. CLARKE

The Execution and Prioritization of Repair Support System (EXPRESS)[1] is the heart of the Air Force Materiel Command (AFMC) Lean Logistics program. It is operating at the air logistics centers (ALC) for daily execution decisions for repair and distribution of reparable items. While the system has shown success in the depot component repair program, it is often seriously hampered by depot resource constraints. This prevents repair actions as directed by the customer needs shown in EXPRESS. Often, lower priority work is done ahead of higher priority work because the required depot resources are not in place when needed. Therefore, repairs often do not follow the EXPRESS prioritization. This sometimes leads customers to believe EXPRESS is not performing correctly. A planning system is needed that is consistent with the Depot Repair Enhancement Program (DREP) philosophy and consistent with the EXPRESS execution. This planning system should address resource constraints and provide an integrated viewpoint. The EXPRESS Planning Module is designed to fill these needs.

A basic tenet of the DREP process is that it addresses only current needs. Therefore, the original execution version of EXPRESS did not rely on the forecast or projections of needs but rather concentrated on prioritizing the current needs and helping the execution process to satisfy them with depot resources that were already in place and available for immediate use. This process was developed during the Cornet Deuce (two-level maintenance test) at the Ogden Air Logistics Center (OO-ALC), which was conducted to determine if the depot component repair program could equal the performance of intermediate base-level maintenance and reduce Air Force expenditures. There was nothing included in the test that provided for longer term planning to acquire the needed depot resources in time for the day of repair execution.

Soon after the start of the Cornet Deuce test, it was evident that a planning function was necessary to accommodate the varying repair workload that came with two-level maintenance. Adding to the variability were other weapon system program changes (phaseout or increasing requirements) as was the case with the F-4 and F-16 weapon systems. While the EXPRESS system was demonstrating a capability to increase weapon system availability and balanced support it was often restricted by the inability of the depot to perform the requested component repairs because resources were not available at the needed time.

Further, there were no existing capabilities that globally viewed all the resources needed to manage the depot component repair program. Considerations needed to include multiple sources of repair such as contract repair and other ALC repair that was being done, new buys, other sources of supply, and finally depot constraints (funds, capacity, carcasses, and parts). These factors all interplay and cannot be treated separately.

Another factor that continued to cause the depot to acquire inappropriate resources was the lack of the capability to forecast repair constraints and prioritize the resources needed to resolve those constraints. When one of the resources was insufficient to meet the total customer need, the depot had no way to know which workload was not to be covered. For example, when there were insufficient funds to buy all the piece parts, there was no way to buy only the most important parts and to coordinate and synchronize those decisions with the other resource needs.

In early 1997, a request was submitted to HQ AFMC for OO-ALC to lead an effort to develop a business process that ensures repair resources are in place to meet the demands of execution. It was envisioned that this process would fill planning voids and complement existing processes. At that time, a planning version of EXPRESS was conceived to support this business process. OO-ALC assumed responsibility for developing a prototype version of EXPRESS that would further define the requirement. The working prototype capability became the initial increment of the EXPRESS Planning Module (EPM).[2]

Building-Block Approach

A building-block approach has been used to develop the prototype EXPRESS planning module. This approach takes advantage of existing capabilities while incrementally building new capabilities that support repair planning. The foundational building block for EPM is EXPRESS for execution. The main contributions of this building block are the software environment, the rich supply of item data and scenario information, and the underlying logic of the Prioritization of Aircraft Reparables (PAR) model. A second building block is the Warner-Robins ALC (WR-ALC) EXPRESS pilot[3] capability that was implemented in July 1997. This effort produced the weapon system priority logic[4] that facilitates allocating repair dollars across weapon systems and also provides a 30-day repair and financial planning capability from a source-of-supply (SOS) viewpoint. The third building block was an OO-ALC 30-day planning capability that enhanced the WR-ALC pilot by interfacing contractor asset data, thereby providing integrated organic and contractor repair plans. The final building block is the EPM prototype that extends the planning horizon beyond 30 days to as much as 1 year and beyond, given scenario data that supports the longer time horizons

Objective and Scope of EPM

The objective of the EXPRESS Planning Module is to provide information that enables repair resources to be in place when needed for repair execution.

Currently EPM is focused on the planning needs and decisions within an air logistics center. The primary repair resources being addressed by the system are carcasses, repair dollars, component parts (bit/piece), and shop hour capacity. The system will either treat these factors as a constraint and identify the shortfall or identify the level of augmentation required for each to meet full customer demands. EPM explicitly considers both organic and contract repair and multiple sources of supply.

In accomplishing this objective, the system addresses both SOS and source of repair (SOR) viewpoints. Table 1 summarizes and contrasts these two viewpoints. The SOS viewpoint takes into account all items that an ALC manages, and in this role, the system seeks to provide planning support in the three areas shown in Table 1. In contrast, the SOR viewpoint is concerned with all items that an ALC repairs, and in this role, the system provides planning support in the four areas itemized under SOR Viewpoint in Table 1.

Technical Overview

Figure 1 provides an overview of EPM in terms of system input, process, and output logic flow. These areas are discussed in sequence.

Inputs

The *Inputs* portion of Figure 1 provides some insights into the technical nature of EPM. The scenario and weapon system goals are provided by the major command scenario subsystems that support other EXPRESS activities. The dynamics of this input information allows EPM to be responsive to programmed and unprogrammed changes related to the flying hours, number of aircraft assigned, unit and weapon system locations, and other similar parameters. The level of funding is another input to the system, and the dynamics of the Materiel Support Division cost authority periodically allocated to the ALCs can be used as a constraint in the system. The item characteristics for reparables are primarily obtained from the D041 and Requirements Execution Availability Logistics Model (REALM). Characteristics related to component parts come from the bill of materials. Also, an interface to the D075 is available to facilitate treatment of actual national stock numbers (NSN) in some functions versus subgroup master NSNs only. The D035 system is the primary source of asset information for the depot and base levels. This information can be updated at the beginning of each day EPM is executed so as to provide a near real-time asset picture. Furthermore, three additional interfaces have been added to EPM to provide a more complete asset picture over the entire planning horizon. First, an interface to D035A is available to provide visibility into on-hand assets associated with contract repair. Second, to complete the asset picture for contract repair, an interface with the G072D is available that provides the number of assets in the *funded but unproduced category*. Third, an interface to the J041 is available to project, over the planning horizon of interest, new buy quantities to be delivered by fiscal quarter. Finally, in the *Inputs* area, interchangeability and substitutability (I&S) data from the D043 provide the complete cataloging information to translate between the item characteristics and on-hand asset data.

Processes

The *Processes* portion of Figure 1 shows the PARs model, the Single Prioritization Across Weapon Systems (SPAWS) logic, and the Supportability Model as the three primary logical processors for EPM. While PARs and the supportable model are the same models used in the EXPRESS execution system, they are employed differently for planning.

PARs, with its underlying aircraft availability logic,[5] is the primary tool used for projecting the reparable item needs over the planning horizon. The principal result from PARs, as it operates

	SOS Viewpoint	SOR Viewpoint
Scope	All items managed by an ALC	All items repaired by an ALC
Functional Planning Support Areas	• Define financial plans for the allocation of funds to supporting SORs. • Determine workload allocations between organic and contractor SORs. • Formulate SOR repair plans in support of SOS needs.	• Assess availability of carcasses to accomplish planned repair. • Evaluate repair dollar allocation to support planned workload • Quantify component parts required to support repair of reparables. • Define/evaluate shop capacity to execute projected workload.

Table 1. Contrasts of SOS and SOR Viewpoints in the EXPRESS Planning Module

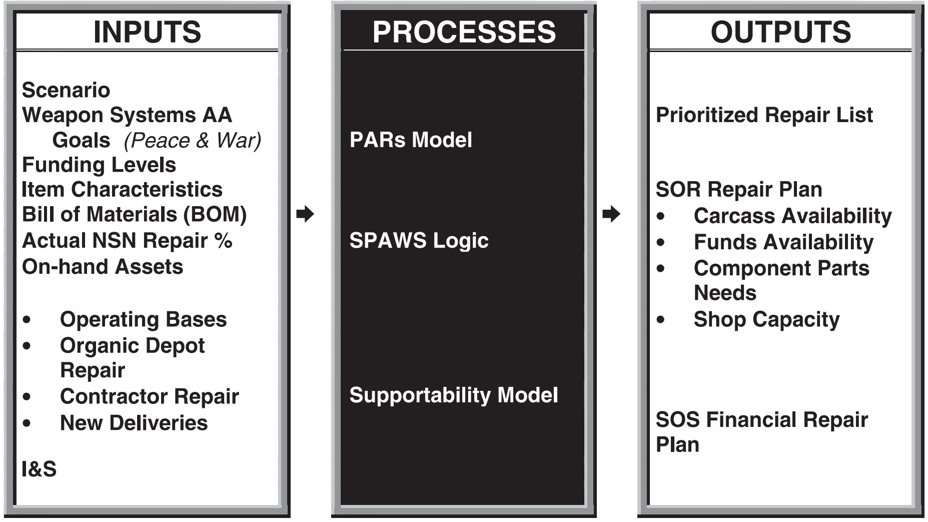

Figure 1. Overview of the EXPRESS Planning Module Technical Approach

in EPM, is a prioritized list of repair requirements by NSN for the planning horizon of interest.[6] The functionality of PARs considers both the peacetime and wartime (readiness spares package) needs of bases/units.

The repair priorities generated by individual PARs are robust within weapon systems; however, it does not allocate significant, common resource quantities across weapon system priorities.[7] The SPAWS logic, noted in Figure 2, is a process that supports multiple weapon systems based on a predetermined percentage of funds and corrects the PARs limitation. Therefore, results from the SPAWS logical process provides a single priority list to EXPRESS and EPM that makes it possible to allocate all resource types across weapon systems.

The Supportability Model[8] operates on the portion of the priority requirements that are to be satisfied by repair. In EPM, resources are allocated within the Supportability Model in the following order: carcasses, repair dollars, component parts, and shop capacity. Carcasses include not only those on-hand or in the in-transit pipeline to the depot but also those that are expected to be sent from the operating base to the depot over the planning horizon. Repair dollars are applied against planned workload after carcass availability has been considered. Therefore, the planning requirements, which successfully pass the Supportability Model process for funds, provide a realistic starting point for component parts requirement and capacity planning. The Supportability Model addresses component parts needed to support reparable repairs in two ways: (1) by determining the portion of the repair requirement supported by carcasses or allocated funds, which can also be supported by onhand parts or (2) by computing the needs for parts[9] and *netting out* the bit/piece quantities needed to accomplish the funds-supported repair requirements. The second way is the one most commonly used in EPM. Finally, the shop capacity resource in this initial EPM prototype is the labor hours available over the planning horizon.

Outputs

The *Outputs* portion of Figure 1, shows categories of information related to the processes. Fundamentally, EPM logic generates information at the NSN level, and the lowest building block of data is a repair action that has a priority relative to all other repair actions. Each repair action can be identified to a source of supply and source of repair and further down to a repair shop (for example, Production Shop Scheduling Designator [PSSD]). Also, through the Supportability process, each potential repair action is *evaluated* and *graded* in terms of carcasses, repair dollars, component parts, and shop hours.

Figure 2 shows the main menu of the user interface to EPM reports.[10] The output system is a web-based capability. As can be seen, the menu is divided into five main areas that contain reports associated with Inputs, Financial Plans, Repair Plans, Summary Data, and Constraint Management. A brief characterization of the type of information available in the reports is contained in the callout boxes shown in Figure 2.

The output system provides the capability to capture and simultaneously maintain output from multiple runs of EPM. Also, many of the reports offer the capability to stratify the information by shop or NSN. There is also an automated help function that is accessible when viewing a report. This help function provides a description of the report and a definition of any data element used in the report.

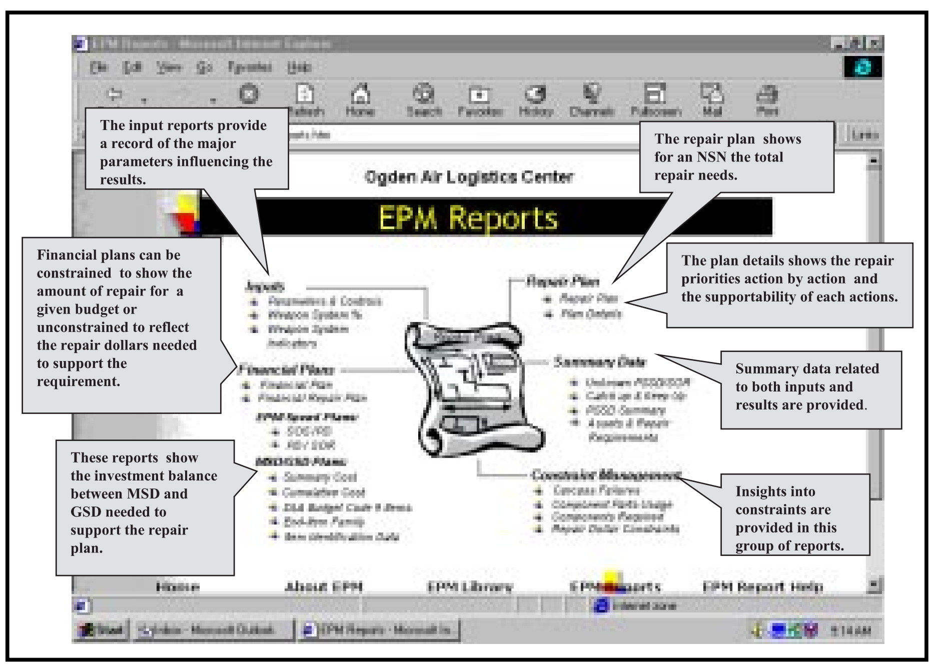

Figure 2. Web-based EPM Reports Menu

System Software Environment

Like the EXPRESS execution system, EPM operates in the Windows NT client-server environment and uses the SQL server database management system. The specific server requirements are as follows: Windows NT Server 4.0, SQL Server 6.5, and Microsoft IIS 4.0 with ASP and FrontPage Extensions. The client requirements are for a web browser such as Microsoft Internet Explorer 4.0 or later.

EPM shares much of its input data needs with the EXPRESS execution system. However, there are significant additional data needs related to contractor asset data, new acquisition deliveries, and multiple SOR allocations. These unique EPM data needs may converge with future EXPRESS execution needs as it is expanded and renovated.

Contrasts Between EPM and EXPRESS Execution

Since EPM and EXPRESS execution are closely aligned, they have many similarities and considerable commonality. However, they also have some key differences that may be useful to contrast for users who are familiar with EXPRESS but just getting acquainted with EPM. The most fundamental difference between the two is forecasting requirements versus capping at current needs. In support of the DREP process, EXPRESS does not make a forecast. Rather it assimilates the current customer needs (often referred to generally as *capping at RO holes*), prioritizes those needs, and performs additional functions to facilitate repair execution. In contrast, EPM starts with the current needs and projects the additional needs that can be expected over the time horizon being addressed. In addition to projecting (forecasting), EPM is also prioritizing repair using the same logic as EXPRESS.

Other contrasts are summarized as follows:

- Whereas EXPRESS operates with a predefined production horizon, EPM provides the capability to extend the planning horizon for 30 days to 365 days and beyond if scenario data is available.
- EPM supports interfaces for additional data over and above that maintained in EXPRESS.
- Contractor assets (for example, D035A).
- Contract funded, unproduced quantities (G072D).
- New reparable acquisitions (J041).
- EPM has added functionality to address contractor repair.
- EPM has added functionality to address dual sources of repair.

Summary

EPM is designed to address repair planning for an ALC from its SOS and SOR viewpoints. Although EPM is in the prototype phase, it can be a viable tool for repair planning in its current form.

EPM addresses both reparable end-items and bit/piece parts and has several key features that include the following:

- Responds to changing scenarios/force structure.
- Uses the current asset data baseline.
- Addresses variable planning horizons.
- Prioritizes constrained resources to maximize supportability.
- Links the priority viewpoint with requirements.

To reach its full potential, EPM needs further development to mature more user capabilities in the supportability resource areas, to refine the output subsystem, and to optimize the system processing for greater efficiency.

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3. Dynamics Research Corporation, *EXPRESS, Warner Robins Pilot Capability, Technical Description*, E2736U, November 1997.
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9. Ogden Air Logistics Center (FMDR), *SLIMM (Shopping List for Item Managers Model)*, White Paper, 1 March 1994, 2.
10. The callout boxes shown in Figure 3 have been overlaid to provide an explanation about items on the menu.

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From Extreme Competitive Advantage to Commoditization

Captain James E. Parco
Lieutenant Colonel J. Davis, PhD
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The Kosovo war revealed a profound gap between the military capabilities of the United States and its European allies . . . . Europe has fallen so far behind the United States in the use of precision-guided weapons, satellite reconnaissance, and other modern technologies that the allies are no longer equipped to fight the same way.[1]

To increase profitability or power, organizations attempt to construct and maintain strategic barriers. To gain these competitive advantages, organizations typically rely on either the resources strategy model, focused on the creation of unique resources and capabilities, or the industrial organization strategy model, which focuses on working within or influencing the relevant industry structure. However, relevant research shows efforts to create these advantages can lead to tremendous disadvantages when exposed to *the creative destruction* associated with technological advance.[2] Given the acceleration of technology in recent decades, it is not surprising that nascent technologies threaten to obviate the advantages created by our military-industrial complex.[3]

Currently, by any measure, the US military and its defense contractors enjoy a relative advantage over their respective competitors. This is well illustrated by the results in both Operation Desert Storm and Noble Anvil. However, in short order, new technologies can provide—or take away—the *extreme competitive advantage* (ECA) currently enjoyed.

This article advocates adapting to new technology, while examining its impact on several sources of current competitive advantage, including centralized manufacturing, mass production, and reclamation. A Schumpeterian model is suggested.[4] Current research provides a strong message: those presently in power, even when ECA is attained, rarely survive the creative destruction of radical technological change.[5] Learning from these examples, the military-industrial complex must be ready to embrace change, even when the early result is a loss of relative competitiveness.

> Of all the things that can change competition, technological change is among the most prominent. [6]

Current Military Environment and Sources of Advantage

For a variety of reasons, the United States has gained a position of ECA relative to its potential adversaries. The technological difference between US weapon systems and that of any competitor has afforded the United States the opportunity to scale back the arms race and focus on other national priorities. In recent years, military installations have been closed and all of the Services reduced markedly, in part, because of smarter, more efficient weapons. This downsizing effort has affected the defense industry dramatically, resulting in large-scale consolidation activities.[7]

A primary reason for this dominance and ECA has been the research and development emphasis of the American economy. For example, the United States has led the way in developing and implementing computer technology. The robustness of the US economy has allowed relatively high levels of funding for research and development (R&D) in both the public and private sectors. In addition, the size of the US consumer base, including military consumption, has enabled a tremendous advantage in terms of capital investment, which has often resulted in economy of scale advantages. The US economy also provides ready access to the many components required to assemble today's complex weapons.

The list of advantages—and their sources—could continue for pages. Clearly, the United States has achieved, in terms of national defense dominance, extreme competitive advantage. It is hard to imagine other nations or consortiums of nations competing seriously with the United States under the current industrial structure. Hence, the only serious threats to the US ECA are likely to come from radical changes in technologies.

Creative Destruction: Historical Examples

Two models dominate the strategy landscape. One of these models, the Industrial Organizational (IO) model, arose from economists studying the structure of industries. This model emphasizes that the performance of firms (primarily measured in terms of profitability) is determined by the structure of the industry and concomitant conduct (strategy) of the firm. Under this model, the existence and value of barriers to entry,[8] the number and relative size of firms, product differentiation, and the elasticity of demand[9] define industry structure. Thus, industries with high barriers to entry, few firms, significant product differentiation, and high elasticity of demand tend to be particularly profitable. More recently, a resource model of competitive advantage has come into vogue with strategists arguing about the *flow and stocks* of unique capabilities.[10] Both of these popular models "presume a level of stability in the competitive dynamics facing a firm sufficient to allow a firm to anticipate competitive threats and opportunities and to respond to those opportunities."[11] Historical precedent and accelerating technological change are setting the stage for an environment where this stability assumption may be dangerous. Thus, in formulating a strategy for future competition within the defense industry, analysis must be based on an economic model that presumes environmental instability.

There are ample precedents for concern about the loss of ECA brought about by the creative destruction of technology. A good example is Great Britain's decline throughout the Industrial Revolution.[12] Early in the Industrial Revolution, Great Britain enjoyed ECA-like advantages in nearly all manufacturing activities, including those related to military operations. Interestingly, Crafts found "the entrepreneurial choice of technique in 19th century Britain was economically rational."[13] That is, the economic decisions made by the British were easily justified using either the IO or resource strategy models of today.

Despite the rationality of British decisions, the United States came to dominate manufacturing because each conducted industrial relations quite differently. While the British retained and increased their dominance in terms of production and craft control on the shop floor, Americans embraced technological innovation. The resulting American success was, at least in part, because "the incomplete labor contracts that they [British] entailed impeded the sort of technical change which involved large investment of sunk costs."[14] The research also shows "the different organizational and industrial relations structures represented the outcome of investment decisions taken in the context of different market environments, of which an important aspect was much greater size and standardization of the American market."[15] Thus, despite British decisions that rationally followed recommendations of our popular strategy models, American manufacturers, in embracing technological advancements, successfully competed with British manufactures and, in the end, obtained and maintained a long-term competitive advantage.

The model implicitly used by America is derived from Schumpeter's evolutionary economics. In contrast with the two popular strategy models, Schumpeter focused on major revolutionary technological changes and market shifts. Schumpeter argued that competition was secondary to innovation. Schumpeter saw the essence of capitalism as the process of creative destruction whereby new ideas and new technologies continually eliminated the competitive advantages developed for older technologies. In addition, he believed firms were incapable of accurately predicting changes in market structure, industry structure, technology, and product development. He noted when a major technological revolution occurred its effects on the market and industry were often not fully understood for some time, preventing firms from making necessary adaptive changes *ex ante*.[16]

Thus, taking a Schumpeterian view, the only way to survive and thrive in a competitive environment is to continually redefine the market, industry, and organization. An organization or firm must be more adaptive than its competitors. However, the answer is not simply to adopt every new technology. Investing heavily in a new technology is risky; if that technology does not become dominant, the investment costs could jeopardize long-term viability.[17] Since being the *first mover* to a new technology can be prohibitively expensive—and perhaps impossible given the difficulty of tracking all the potential technological possibilities—organizations must maintain a strong *second mover* capability. As research demonstrated for a variety of firms[18]—and specifically in the case of Great Britain[19]—it is particularly difficult for organizations enjoying ECA to move to new technologies. Schumpeter believed firms could only maintain a competitive advantage if they were willing to participate in the destruction of their industry structure. Thus, to maintain competitive advantages, the defense industry must be willing to accept less than ECA for some period of time if that is what it takes to adapt to radically new technologies.

A Potential Threat: SF³

Some firms in the defense industry believe a technology capable of destroying the structure of the defense industry may already exist. Imagine a system capable of manufacturing any shape that could be drawn in unbounded geometric complexity from any substance that will melt. That technology is called Solid Free Form Fabrication (SF^3). In limited form, this technology already exists. Presently, the vast majority of efforts to develop SF^3 technologies are within the automotive sectors of industrial nations. Given the disparity between military and commercial R&D expenditures on such technologies, the commercial sector will probably set the pace, at least initially, in terms of developing SF^3 processes.

SF^3 technology is a laser-based manufacturing process that promises to permit customers to manufacture nearly any structure they desire, anytime, in practically any location. By using a variety of raw materials (for example, ceramic, titanium, steel, copper) and computer-aided designs (CAD) from commercial off-the-shelf CAD software packages, highly complex structures could be produced in a remarkably short period of time for a very reasonable cost. Since assembly processes are minimized, the concept of SF^3 eliminates the need for large plants, expensive tooling and equipment, and scores of production staff. Instead of the status quo, one person simply loads a 3-D CAD model and specifications of the item to be manufactured and fills the *machine* with raw material, possibly in powder form, and the closed-system produces the desired item. The primary production constraint is the size of the *box* that houses the SF^3 system. Defense contractors currently developing SF^3 technology maintain that using SF^3 technologies will reduce manufacturing times from years to months. Considering what could be produced (a titanium tank turret? an unmanned aircraft frame?), the ramifications of this technology are potentially huge.

The concept of SF^3 technology, taken to an extreme, is just that, a concept. The possibility, however, that it will eventually come to fruition, as envisioned by several major commercial automotive firms, as well as academia, should be of concern to the US military.

Sample of Dimensions of the SF^3 Threat

Production Decentralization

SF^3 technology promises to dramatically alter the current centralized manufacturing model. Over the past few decades, developments in computer-aided design, coupled with computer-integrated manufacturing, have allowed industry to produce increasingly complex products with remarkable speed and accuracy. However, despite these advances, one factor has remained constant: aggregation of production. Driven partly by the need for large facilities, partly by availability of labor, and partly by economies of scale, manufacturing has remained confined to large industrial complexes. To date, manufacturing weapons systems or spare parts anywhere other than in large defense plants has not been economically feasible.

SF^3 production allows a move to decentralized production. This decentralization could significantly alter the way the military operates. As an example, decentralization could allow the elimination of spare parts stock. No longer would the Navy have to deploy an armada loaded with spare parts and equipment. Instead, each battle group would need an SF^3 system, a sufficient supply of precursor materials, and a collection of CD-ROMs containing part specifications and CAD models. Production decentralization would allow a deployed commander to manufacture nearly any spare part conceivable on demand. SF^3 technology would also redefine the idea of just-in-time manufacturing. When an order arrives at an SF^3 location, the supply manager would simply enter the manufacturing specifications, along with the appropriate precursor material, into the system. Inventory costs would be driven down, and with the elimination of several management levels from the production process, lead times would be dramatically reduced.

The decentralization impact of SF^3 possesses a serious threat to the US military's ECA. Once these systems become readily available commercially, anyone who wants to become a defense manufacturer simply needs to purchase or build one of the units. Add some computer data and essential raw material, and a new competitive threat has been born. Once in possession of basic SF^3 technology and product specifications, nearly anyone would have the capability to become a defense contractor—friend or foe. Traditional means of logistical resupply may still remain valid for food; water; petroleum, oil, and lubricants; medical supplies; and other consumables, but many critical, durable items could be manufactured at nearly any location.

Mass Customization

SF^3 is, by nature, a *mass customization* capability, which could further erode US defense dominance. The size of the US economy has allowed a greater degree of theater and operation-specific production. For example, the Air Force, Marine Corps, and the Navy have generally produced different aircraft for each of their flying missions. Potential adversaries who generally lack the economic base required for aircraft specialization simply cannot compete. Less affluent adversaries are often forced to buy more general-use—consequently, less capable—aircraft. The mass customization possibilities of SF^3 will potentially allow more countries to specialize, at levels beyond even those currently addressed by the United States

While the idea of being able to customize airframes is truly revolutionary, an incredible technological leap, the concept of SF^3, offers not only this but also the ability to integrate fuel, hydraulic, and electrical systems into a single, monolithic design optimized for environmental conditions in which the airframe will be employed. In fact, customization may be possible from one unit to the next. Although the Air Force has long been able to purchase aircraft suited to different environments and roles (ground attack, fighter, bomber, reconnaissance, cargo), by using SF^3 weapon systems can be optimized to fit a particular environment. For example, an aircraft optimized for operations in the mountains of Bosnia would have different characteristics than one customized for the deserts of Iraq.

Reclamation

Finally, consider the potential effects of SF^3 on *reclamation*. With the ratification of Strategic Arms Reduction Treaty II, the United States eliminated a sizable portion of its bomber fleet. Many of the B-52s that were taken out of the active inventory now sit idly at the Aerospace Maintenance and Regeneration Center (AMARC) at Davis Monthan AFB in the Arizona desert. Along with these aircraft stored at AMARC are many other obsolete aircraft. The point is current defense production processes require vast amounts of raw materials, little of which are available for reclamation once a weapon system becomes obsolete or wears out. Hence, under the current environment, competitive advantage is tied to a large economic base, which allows for the amortization of the costs of raw materials. One visit to Davis-Monthan validates the current competitive advantage of America's large

(Continued on page 42)

The Problem with Aviation COTS

Lieutenant Colonel L. D. Alford

Commercial off the shelf —or COTS—has become a byword for acquisition reform, but there are significant risks associated with the use of COTS products in military systems. These risks are especially acute for aviation systems.

To take advantage of the fast pace of technological advances in industry, the Department of Defense (DoD) is acquiring commercial products and components for use in military systems. COTS items provide the Department of Defense with numerous potential benefits. Primarily, they allow incorporation of new technology into military systems more quickly than typical developmental programs. COTS can also reduce research and development costs. Even more important, the Department of Defense has looked to COTS purchases to help reduce operations and support costs for military systems. Figure 1 shows why this is highly desired: the cost of operations and support is almost three-quarters the overall cost of a typical system. With this in mind, what could be the worst misfortune to befall an item procured as COTS? Could it be that the item changed and the original was no longer available commercially? What if the commercial replacement would no longer work in the military system for which it was procured? The very worst misfortune, which incorporates both of these problems, would be if the item were to suddenly become government unique—no replacement available commercially. Becoming government unique would not entirely defeat the purpose of a COTS acquisition, but it would significantly affect support—the longest tail and, as shown in Figure 1, the greatest cost in the acquisition life cycle. This misfortune could never affect our COTS procurement—or could it? In any COTS acquisition, the acquirer needs to have already planned for this eventuality.

Government unique is the conceptual opposite of COTS. An item is government unique when the only source or user of the item is the government. An item is a discrete unit that can be individually acquired for the logistical support of a system. A system, in this definition, is the higher level mission component for which the item is procured. For example, an aircraft and its support equipment are a system, but a radio installed in the aircraft is an item. Whenever a manufacturer discontinues or makes a change to a COTS item, the item can become government unique. When the manufacturer changes the item, if the government does not either acquire the variant or reflect the change in the systems incorporating the item and the systems' documentation, the original becomes government unique. After a manufacturer makes a change to an item, the government might be able to purchase and use the new variant without any negative effect to the system. In this case, though the original item is now government unique, the change would not affect the form, fit, interface, or mission characteristics of the device. Unfortunately, manufacturers' changes routinely affect

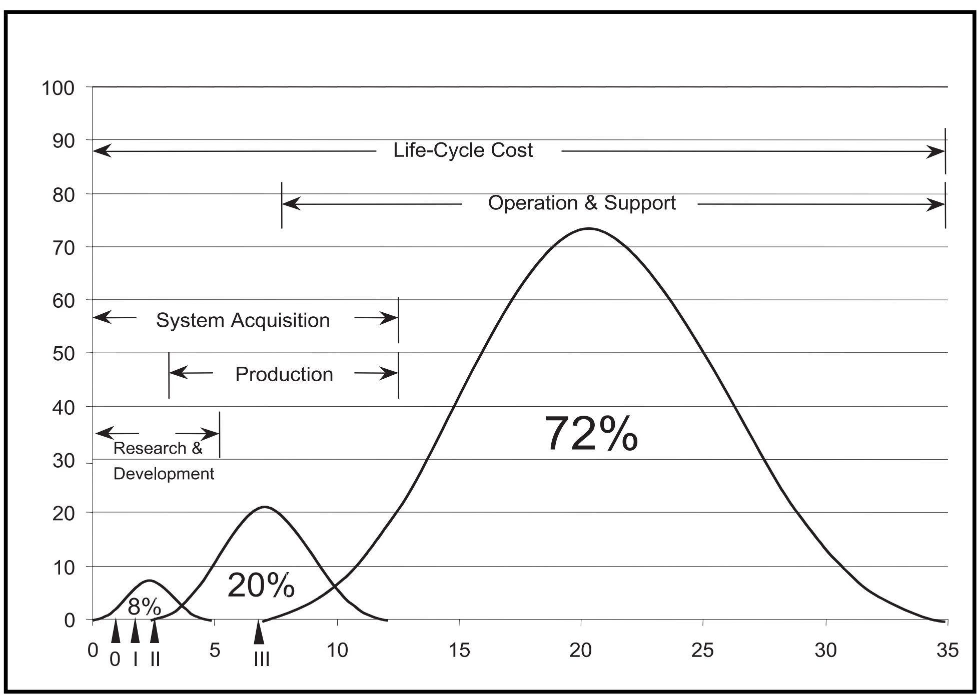

Figure 1. Typical Cost Distribution[1]

these characteristics, and the effects of these COTS item changes for systems incorporating them are significant. The problems of changing form, fit, and interface should be obvious; if the variant item is to be installed and operate correctly, these characteristics generally cannot change. To accommodate form, fit, and interface changes, the acquirer must usually make modifications to the system. Modifications are costly and usually result in the original item becoming obsolete. Changes to mission characteristics do not necessarily result in system modifications. However, if they affect the overall performance or capability of the system, they can cause significant problems. For example, if the new item has an operating temperature range less than that of the original, the system could fail when used in an environment where temperatures exceed operating limits.

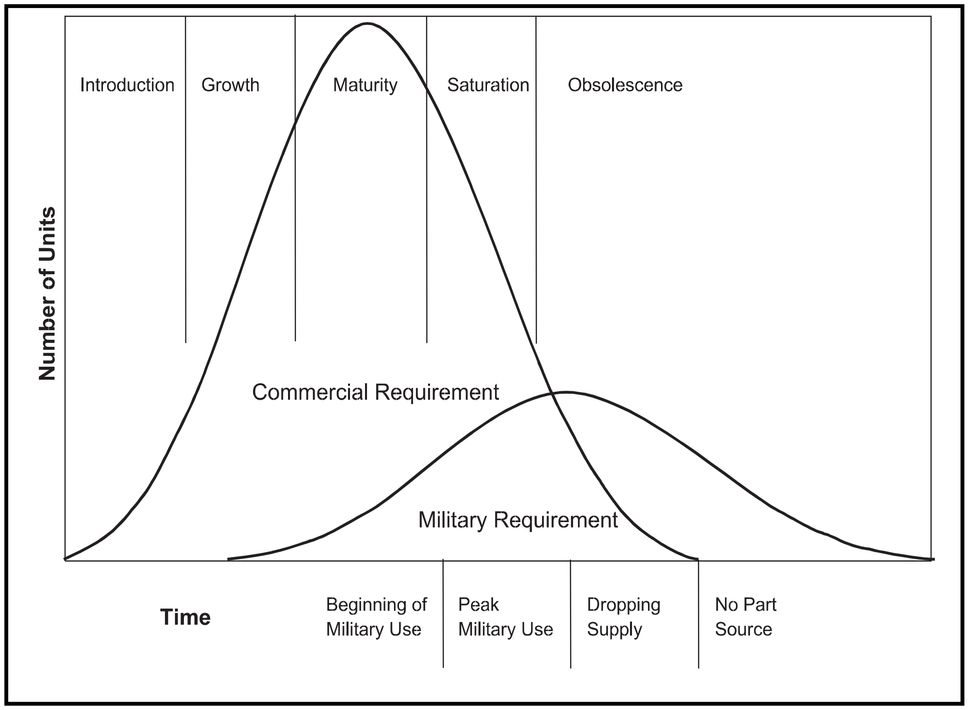

Figure 2. COTS Obsolescence[2]

Although configuration changes can cause create in a logistics program, the most devastating cause of government uniqueness occurs when a manufacturer discontinues an item. Figure 2 shows that, for a large number of COTS acquisitions, this is inevitable. The life of a typical military acquisition exceeds 20 years, yet the life of a typical civil product, especially electronics, is much less. From our own experience, we know it is almost impossible to purchase an *ancient* Z80-based computer, but right now, the Z80 lives on in the Air Force's AP-102 computer. This problem is not isolated to the electronics industry. For example, electronic gauges are replacing aviation *steam gauges*, the mechanical gauges on instrument panels. As a result, sources for mechanical components are becoming scarce, and they are difficult to obtain.

The concepts outlined provide the definitive framework under which COTS must be understood. Without notice, the manufacturer is free to make changes to or discontinue production of the COTS item. As long as the manufacturer's item changes do not affect characteristics or logistics supply, the acquirer has no problem. When changes do affect form, fit, interface, mission characteristics, or logistics supply, these changes become a significant problem for any COTS acquisition. This is especially true for aviation COTS.

Two specific difficulties, airworthiness and forced modifications, result from manufacturer's changes to aviation COTS. Airworthiness is the primary safety characteristic of any aircraft. It is the primary element proven in the testing of the aircraft. The Federal Aviation Administration (FAA) certifies the airworthiness of most COTS items for aircraft, and these items must be certified in the system as well as individually. Military system certification, except for FAA-certified aircraft, is done wholly by the aircraft's configuration management (CM) authority. In the Air Force this authority is the single manager. This means that a simple change in mission characteristics, including improved functionality, will always drive a recertification of the aircraft. This recertification can range from a paper review to full flight test. The rate of change in COTS items is significant. This is especially true for aviation COTS. Considering the rate of change in COTS items, frequent recertification is a daunting prospect for the CM authority. In addition, COTS item changes can also drive changes to the specifications and technical data of any system on which these items are installed.

The other difficulty for aviation COTS, which also affects any system, is forced modifications. A forced modification is a system's modification caused by the change of form, fit, interface, function, mission characteristic, or logistics supply. When logistics supply is affected, the acquirer must support the discontinued item or find a replacement. The latter may force a modification. More common in aviation COTS is an FAA-directed (airworthiness directive [AD]) change to an item.[3] These directives are FAA regulation-based orders that mandate a change to an aviation item or system. Airworthiness directives are regulatory in nature, and "no person may operate a product to which an airworthiness directive applies except in accordance with the requirements of that airworthiness directive."[4] The manufacturer has two choices in implementing the AD: discontinue the product or make the required change. The user of the item also has two choices: get a replacement product, if available, or make the changes required by the directive. When the change affects the form, fit, or interface of the item, an AD forces a modification to the system. For FAA-certified aircraft, the system must also receive FAA flight certification. For government certified aircraft, the CM authority must modify the system and certify airworthiness. However, the government is under no obligation to change its COTS items to accommodate an AD. If the government does not change a COTS item to comply with an AD, the item becomes government unique. Because the government self-certifies, commonly, non-FAA certified government aircraft do not make AD directed changes. Further, because in many cases, the government does not subscribe to technical changes from manufacturers, the CM authority may not be aware of ADs that pertain to a system's components. This problem is exacerbated when the CM has established a depot for a COTS acquisition and is, in that case, supporting the component without knowledge of or real commonality with the original item. Usually ADs are issued more than once a year affecting well-established air vehicles; however, thousands of ADs may affect a single aircraft model.

All this boils down to the fact that, for aviation, a COTS item will become government unique in a very short period of time—from a few months to a year after the acquisition of the item. Government uniqueness means forced review, modification, support changes, and recertification when the change is recognized—or blissful ignorance and risk if the change is not recognized.

COTS Support Strategies

What can be done to prevent these problems for aviation systems specifically and all systems generally? One solution has been mentioned, and this solution has been accomplished with varying degrees of success since the first acquisition of COTS items.

- **Depot.** This approach is the acknowledgment of an item's potential government uniqueness before the manufacturer makes any changes. In this strategy, the acquirer purchases spares and builds a government depot activity to support the item. This solution does take advantage of the COTS item commercial development, but the overall cost savings may not be significant because the longest tail, the support tail, is at least as long as any normal government item development. In fact, the support tail may be costlier because the government has not been involved in the item development. Many programs use this strategy; the C-130 improved auxiliary power unit program is one example.
- **Lifetime Spares.** Another similar solution is to purchase enough spares for the total life of the system and item. The AP-102 computer program used this strategy to ensure sufficient Z80 chips to support the life of the system. Again, this is not an optimum solution because it usually increases the item's logistics tail. In this case, if the item's life expectancy is less than predicted or the item's life is extended, the government has no other recourse than to entirely replace the item or to develop a support capability. These two solutions, government depot and lifetime spares buy, prevent forced modifications and subsequent airworthiness certification requirements. They can also introduce risk. In addition, they defeat two major potential advantages of COTS: the ability to reduce the support tail and the ability to take advantage of future commercial developments in the item.

There are four other solutions to these problems that do take full advantage of the possibilities of COTS acquisition, but each is fraught with its own risk. Each of these solutions is a variant of what is commonly known as contractor logistic support (CLS).

Purchase Technical Information. In the first alternative, the acquirer can purchase the servicing information support of the manufacturer. This allows the CM authority to make decisions based on changes to the item. If the CM authority knows of a manufacturer's changes to an item, the CM can choose to acquire a replacement or modify the system as required to allow continued use of the variant item. The CM has three options. First, when an item changes and the decision is made to replace the item, the CM must acquire and certify the new item. Second, if the item is retained with changes, the CM must certify and possibly change the system. And third, if a decision is made to not make any changes to the item, the CM must set up government-unique support. The advantages of retention or replacement (options 1 and 2) are the continued COTS logistics tail and guaranteed item certification. The CM must still recertify the system. If the item is retained in its original configuration (option 3), the decision to support a government-unique item leads to a typical high-cost government logistics tail. This pick-and-choose method of systems support probably has not been used intentionally. However, after a manufacturer has made unexpected changes to a COTS component, many programs have found themselves in this situation.

- **Purchase Manufacturer Support.** The second alternative is the acquirer can purchase manufacturer support for the item. The risks in this are similar to that of purchasing servicing information support; however, the manufacturer has more incentive to keep the item within form, fit, and interface configuration for the system. When changes in the system are required to support changes in the item, the manufacturer can aid the CM authority. This is a very common method used to support COTS.
- **Purchase Manufacturer Modification Support.** In the third alternative, the acquirer can purchase the full, integrated support of the manufacturer. This allows the manufacturer to make changes to the system, along with changes to the item. The contractor may have some Total System Performance Responsibility (TSPR), but the CM authority must still recertify the system. The AC-130U is using this method to manage COTS in its new Integrated Weapon System Support program. This is the most common method used today to support COTS items and systems through CLS.
- **Purchase Full Manufacturer Support**. Fourth, the acquirer can purchase the full system support that would allow an integrator to automatically make changes to the system necessary to accommodate any item changes. In this scenario, the contractor would have TSPR and certify the weapon system. This fourth option is used primarily to support FAA-certified government aircraft. It could potentially be used to support any government aircraft or system incorporating COTS items.

The message should be plain. COTS acquisitions lead the acquirer down two support paths: government-unique, high-cost logistics and COTS manufacturer support. Both of these paths involve risk and guarantee future costs for any system incorporating COTS items. The potential of COTS acquisitions is embodied in a lower cost development, initial acquisition, and support costs. That potential must be balanced with the knowledge that COTS acquisitions will either force modifications and recertifications or lead to a typical government-unique logistics tail.

COTS for aviation is a viable method of aircraft and aviation acquisition, but it is not a simple solution. It requires careful planning and forethought that must be incorporated into any program contemplating a COTS acquisition.

Notes

1. John F. Phillips, DUSD (L) September 1996, and John W. Jones, Ed., *Integrated Logistics Support Handbook*, 2d Ed., 1995.

2. Joint Stars AFPEO/C3 briefing.
3. *Federal Aviation Administration*, Part 39—Airworthiness Directives, Federal Aviation Regulations. Washington DC: Government Printing Office, February 1996.
4. *Ibid*.

Lieutenant Colonel Alford is an aeronautical test policy manager at the Air Force Materiel Command.

Air Force Board of Logistics Advisors

Most Significant Article Award—Vol XXIII, No. 2

The Editorial Advisory Board selected both "A Global Infrastructure to Support EAF"—written by Lionel A. Galway, Robert S. Tripp, Chief Master Sergeant John G. Drew, C. Chris Fair, and Timothy L. Rand—and "The Technologically Hollow Force of the 21st Century—written by Colonel Randy A. Smith—as the most significant articles in Volume XXIII, No. 2

Most Significant Article Award—Vol XXIII, No. 3

The Editorial Advisory Board selected both "Contractors on the Battlefield"—written by Colonel Steven J. Zamparelli—and "The Logistics Constant Throughout the Ages"—written by Cadet First Class Daniel McConnell, USAFA, Captain Richard A. Hardemon, and Senior Master Sergeant Larry C. Ransburgh—as the most significant articles in Volume XXIII, No. 3.

Contracting

Environmental Contracting Guide
LC199823207—Improvement Study

1. Provides environmental information/instructions to contracting personnel.
2. Provides alternatives and approaches for contracts that may include environmental aspects.
3. Ensures contracts with environmental aspects meet Air Force needs (CONUS and overseas).

TSgt Jeffery B. Feeney, DSN 596-4085

Business Solution Exchange (BSX)
LC199907100—Improvement Project

1. Develops and implements a knowledge management tool (unites policy, process, and people to provide better business solutions).
2. Provides a web-based interactive system linking cross-functional teams.
3. Develops a virtual work space that captures process and products.
4. Operates on commercial off-the-shelf software. Requires a personal computer, web browser, and access to the Internet.

Capt Judson L. Bishop, DSN 596-4085

Quality Assurance Program Coordinator Course
LC199921400—Consulting Project

1. Assists in writing performance-based statement of work course materials.
2. Training material supports implementing AFI 63-124, *Performance-Based Services Contracts.*

TSgt Jeffery B. Feeney, DSN 596-4085

Standard Procurement Systems (SPS): Implementation Phase
LC199915800—Consulting Project

1. Assists the Standard Systems Group Contracting Division deploy SPS Air Force-wide.
2. Provides subject matter expertise and analytical support as needed.

SMSgt Paul E. Banis, DSN 596-4085

Contractor Metrics for Service Contracts
LC199913100—Improvement Study

1. Develops contractor performance metrics for use with service contracts.
2. Develops techniques for analyzing data.
3. Metrics support implementing AFI 63-124, *Performance-Based Services Contracts.*

Capt Jonathan L. Wright, DSN 596-4085

Maintenance

Quality Assurance Tracking and Trend Analysis System (QANTTAS) Y2K Replacement
LM1998134400—Consulting Project

1. Creates a Y2K compliant version of QANTTAS that will serve the quality assurance needs of the Air Force.
2. Uses existing software developed by base-level Air Force Reserve Command units as a benchmark.

MSgt Maura A. Barton, DSN 596-4581

Revised Mission Capable (MC) Rates
LM199906900—Improvement Study

1. Quantifies potential effect on MC rates should the *2-hour* rule, as stated in AFI 21-103, be deleted.
2. Quantifies potential effect on MC rates should the Air Force include *depot-possessed* time in MC calculations.

MSgt Maura A. Barton, DSN 596-4581

Follow-on Technical Support for the Weapons Load Crew Management Program
LM199812000—Consulting Study

1. Ensures the Weapons Load Crew Management Program is exploited to its fullest.
2. Ensures all users are knowledgeable of the program's functionalities.

SMSgt Cedric M. McMillon, DSN 596-4581

Avionic Pod Maintenance and Support Optimization
LM199830200—Consulting Study

1. Assists RAND in examining alternatives to current operational maintenance and support concepts for electronic countermeasure pods and low-altitude navigation and targeting for night pods.
2. Recommends the most efficient utilization of existing resources while not degrading equipment availability or deployability.

SMSgt Eric J. Mazlik, DSN 596-4581

Analysis of Engine Regional Repair as a Future Air Force Logistics Support Option
LM199908301—Consulting Study

1. Assists RAND in examining alternative support options for jet engine intermediate maintenance.
2. Quantifies and analyzes the merits of regional engine repair versus other repair options.

Capt Richard A. Hardemon, DSN 596-4581

Air Expeditionary Force Logistics (AEF) Concept of Operations (CONOPS)
LM199733000—Consulting Study

1. Assists RAND in developing innovative concepts and investigating alternative ways of supporting AEF operational objectives.
2. Formulates specific data collection efforts needed to support AEF CONOPS options.

CMSgt John G. Drew, DSN 596-4581

Support Web Site for Munitions CD-ROM
LM199924500—Consulting Study

Supports HQ/AFSPC tasking to install and maintain the *Senior Air Force Leaders Munitions CD-ROM* as an official use only Internet site.

Capt John E. Bell, DSN 596-4581

Supply

Initial Spares Support List (ISSL) Process Review
LS199718900—Improvement Study

1. Analyzes the initial provisioning process.
2. Determines:
   a. What failure data is computed.
   b. What computational methodology to use with demand data—either estimated or actual.
   c. How to ensure levels sent to bases match the D041 computed requirement.
   d. How assets without demand data should be handled.
   e. What should be done to ensure ISSL levels already loaded match the D041 requirement.
   f. If Readiness-based Leveling should treat ISSLs any differently than other adjusted stock levels.

Capt David A. Spencer, DSN 596-4165

Defense Automatic Addressing System (DAAS) Usage Analysis
LS199832401—Improvement Study

1. Determines advantages/disadvantages for continued use of DAAS, to include:
   a. DAAS functions (editing, routing, and reformatting).
   b. Measurable statistics for data flow (timeliness, accuracy, and so forth.).
   c. DAAS customer support (unit, MAJCOM, Air Force).
   d. DAAS usage (mandatory or not).
2. Determines viability of bypassing DAAS by using newer technologies.
3. If necessary, determines the requirements for bypassing DAAS.

SMSgt Bernard N. Smith, DSN 596-4165

Redistribution Order (RDO) Denial Rate
LS199815600—Improvement Study

1. Determines why the RDO denial rate is high.
2. Determines if wholesale and retail systems are using the same formulas to determine which assets can be redistributed.
3. Determines if the timing of retail-to-wholesale usage data is contributing to the high denial rates.

SMSgt Robert A. Nicholson, DSN 596-5126

Fuels Pamphlet for Expeditionary Aerospace Force (EAF) Operations
LS199826601—Improvement Study

1. Develops a book that emphasizes the importance of fuel and fuel support in EAF operations.
2. Provides a historical perspective of fuels issues/problems with regard to requirements and planning.
3. Addresses/discusses critical issues necessary for successful fuel support.
4. Develops a tool that will provide estimated fuel consumption based on mission design series, sortie rates, and sortie duration.

SMSgt Larry C. Ransburgh, DSN 596-4165

Forecasting and Parts Supportability at Air Logistics Centers
LS199834800—Consulting Project

1. Reviews the Reparability Forecast Model developed by CACI International for the San Antonio Air Logistics Center to help forecast requirements.
2. Determines if the system improves the air logistics center's ability to forecast parts, especially for outside agencies such as the Defense Logistics Agency.
3. Develops procedural guidance that will then be used to aid the depots in using the system properly.

Capt Kevin J. Gaudette, DSN 596-5619

Air Force Seamless Supply Integrated Process Team (IPT) (Module 1: Air Force-Managed Items)
LS199822901—Consulting Project

1. Assists the Air Force Seamless Supply Council in defining the future system requirements needed to eliminate the seams inherent in the existing wholesale and retail supply systems.
2. Provides subject matter expertise, data collection, and analytical support as needed.

CMSgt Robert K. Ohnemus, DSN 596-4165

Air Force Requirements Team Consulting Efforts
LS199822904—Consulting Project

1. Measures the requirements system performance.
2. Makes recommendations to improve policy and performance.
3. Monitors and operates Readiness-Based Leveling.

SMSgt Michael S. Horne, DSN 596-4165

Quarterly Readiness-Based Leveling (RBL) Reports
LS199811202—Consulting Project

1. Each quarter the Air Force Requirements Team extracts RBL data from the World Wide Web (WWW), uses it to generate reports, and posts the reports to the web.
2. Accesses the data, generates reports, and posts the reports on the WWW not later than 72 hours after each quarterly RBL push.

Capt David A. Spencer, DSN 596-4165

Volatility of Readiness-based Levels (RBL)
LS199826400—Requirements Team Study

1. Determines the amount of variability in pushed levels. If the variability in levels is significant, develops and recommends solutions to the problem.
2. Determines the ideal frequency of RBL runs per year.

Capt David A. Spencer, DSN 596-4165

Execution and Prioritization of Repair Support System (EXPRESS) and Primary Aircraft Authorization (PAA) Study
LS199801500—Improvement Study

1. Evaluates how program logic in EXPRESS treats bases with dissimilar PAAs (small versus large PAA).
2. Compares EXPRESS prioritization sort value results for unique versus common assets.
3. Identifies depot repair policies and execution procedures, including funding aspects, which impact Special Operations Forces (SOF) repair prioritization/distribution.
4. Compares actual asset distributions to SOF and common C-130 units since EXPRESS was implemented.

Capt Jennifer A. Manship, DSN 596-4165

AETC Spares Support
LS199802700—Improvement Study

1. Compares AETC and ACC logistics metrics MC, UTE, TNMCM, TNMCS, CANN, IE, and SE for F-16, F-15, T-37, and T-38 units, from fiscal years 1994 through 1998.
2. Conducts a problem item analysis on the above aircraft weapon systems for AETC.
3. Collects data to determine if AETC's current or projected pilot training is or will be impacted by current trends.
4. Determines the feasibility and impact of implementing different alternatives.

Capt Jennifer A. Manship, DSN 596-4165

Performance Metrics for the Readiness-based Leveling (RBL) and the Redistribution Order (RDO) Process
LS199805700—Improvement Study

1. Reviews and updates the Air Force Supply Executive Board-approved performance measurements (metrics) designed to identify and correct deficiencies in the RBL and RDO process.
2. Determines the best method to collect RBL and RDO performance data. Includes:
   a. Source of data for each metric.
   b. Who collects the data.
   c. How to collect the data.
   d. When to collect the data.
   e. How to identify, screen, and correct suspect data.
3. Develops and proposes policy and procedures that address:
   a. Who reports the metric.
   b. Who reviews the metric.
   c. When to recommend systemic changes to improve performance.

SMSgt Robert A. Nicholson, DSN 596-4165

Concept Development for Air Expeditionary Force (AEF) Logistics Support
LS199900701—Consulting Project

1. Assists the RAND Corporation in developing logistics concepts needed to support AEF operations.
2. Develops a logistics command and control concept/system to manage intratheater distribution of assets in support of operations.
3. Develops optimal kit concepts to both minimize the deployment footprint and maximize support in the early days of a contingency with cost as a factor.
4. Determines requirements for war reserve materiel to include location/prepositioning options to best support AEF operations.

Capt Kevin J. Gaudette, DSN 596-5619

Standard Base Supply System (SBSS) Replacement of D035K for Retail Depot Stock Management
LS199900702—Improvement Study

1. Assists the C-5 System Program Office at the Warner Robins Air Logistics Center in a test to determine the feasibility of using the SBSS (or Integrated Logistics System-Supply [ILS-S]) in lieu of the D035K to provide support to the program depot maintenance line at the air logistics centers.
2. Collects data to assist the Air Force in determining if it is advisable to replace the D035K with ILS-S.

Capt Kevin J. Gaudette, DSN 596-5619

National Stock Number Issue and Stockage Effectiveness
LS199919500—Consulting Project

1. AFLMA Project LS199834400 proved national stock number-level (NSN-level) issue and stockage effectiveness is obtainable, and a report of the process was published in July 1999.
2. Encompasses our continuing efforts to collect and transfer the raw data needed to compute NSN-level issue and stockage effectiveness until the software and procedures are transferred to the appropriate agency.

SMSgt Robert A. Nicholson, DSN 596-5126

Analysis of Y-MIC Stocks/D035K Credit Policy
LS199829901—Improvement Study

Develops a credit turn-in policy that provides incentives to maintenance activities to turn in unneeded items from their Y-Maintenance Inventory Centers while still maintaining a balanced stock fund.

Capt Kevin J. Gaudette, DSN 596-5619

Consumable Asset Stockage Policy in a Seamless System
LS199822905—Improvement Study

1. Determines and defines what the retail stockage policy for consumable items should be in the future—recommends stockage policies for both base retail and customer levels that continue to satisfy customer mission requirements but do not significantly increase current inventory investment levels.
2. Determines the need for visibility of consumable assets after issue to the customer and the need to track demand history of these items.
3. Determines the impact of alternate stockage methodologies on the stock fund and determines if credit policy may need to be changed.
4. Determines if the Defense Logistics Agency's Industrial Prime Vendor initiative is cost effective and a viable solution for consumable item management.

CMSgt Robert K. Ohnemus, DSN 596-4165

Operation Allied Force Supply Data Collection
LS199913200—Improvement Study

Identifies data requirements and collects data from all units supporting operations in Kosovo.

Capt Kevin J. Gaudette, DSN 596-5619

Policy for Percent Base Repair (PBR) for D035K Depot Level Maintenance (DLM) Accounts
LS199835200—Improvement Study

1. Determines the correct method of reporting repair/condemnation actions for DLM accounts.
2. Determines the impact to Readiness-based Leveling in allocating levels when the actual repair/condemnation actions at the DLM account are considered instead of zeroing the PBR.
3. Determines the impact of including PBR on the D041 requirements computation.
4. Identifies what causes some items to reflect a positive PBR and which, if any, items should be computing a positive PBR.

SMSgt Michael S. Horne, DSN 596-4165

Policy for Percent Base Repair (PBR) for D035K Depot Level Maintenance (DLM) Accounts
LS199835200—Improvement Study

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3. Determines the impact of including PBR on the D041 requirements computation.
4. Identifies what causes some items to reflect a positive PBR and which, if any, items should be computing a positive PBR.

SMSgt Michael S. Horne, DSN 596-4165

Evaluation of Priority Fills for Two On-Call Air Expeditionary Wings' Readiness Spares Packages (RSP)
LS199925300—Improvement Study

1. Evaluates a proposal to assign a Joint Chiefs of Staff project code to the replenishment of two on-call air expeditionary wings' RSP. Using such a code will result in fewer spares being available to other Air Force units (assuming repair production is not increased to support the replenishment).
2. Simulates the filling of existing shortages of two ACC-provided RSPs from POS assets by first allocating RBL levels to fill the two RSPs and then allocating the remaining POS requirement.
3. Compares the resultant expected back orders to the expected back orders without the priority fill.

Capt David A. Spencer, DSN 596-4165

Review of Depot and Base Floors (Minimum Levels) for Low-Density, High-Reliability Items
LS199922200—Requirements Team Study

1. Determines if worldwide minimum levels on low-density/high-reliability items should be reduced.
2. Recommends changes to existing policy, if appropriate.

SMSgt Woodrow Parrish, DSN 596-5813

Transportation

Air Mobility Command Ground Times Study
LT199905701—Improvement Study

1. Identifies potential aerial port, fuels, and aircraft maintenance procedures to reduce mobility aircraft ground times.
2. Evaluates 60K loader usage.
3. Reviews concurrent servicing procedures, aircrew maintenance reporting procedures, and aircraft servicing requirements.
4. Examines the effects of quiet hours.
5. Identifies aircraft scheduling procedures.

Capt Leigh E. Method, DSN 596-5881

Materiel Handling Equipment (MHE) Capabilities Study
LT199913701—Improvement Study

1. Determines the peacetime and wartime MHE requirements for Air Mobility Command.
2. Determines the maximum capability of MHE if it is operated continuously 24 hours a day for a 2 to 6-day period of time.
3. Verifies break rates and how much cargo the MHE can actually move.
4. Experiments with various types of MHE to determine the best mix to obtain maximum performance.

Capt Todd A. Dyer, DSN 596-4464

Commercial Reliability/Violation Program
LT199915800—Improvement Study

1. Accurately aligns Air Mobility Command contract airlift with commercial practices while satisfying operational requirements.
2. Examines commercial reliability and violation standards and performance.
3. Evaluates impact on military readiness and worldwide performance.

Capt Jeffrey C. Bergdolt and SMSgt Douglas L. Tucker, DSN 596-4464

Logistics Plans

War Reserve Materiel (WRM) Analysis/WRM Prepositioning Tiger Team
LX199722700—Improvement Study

1. Establishes a schedule for future meetings and reviews the current War Plans Additive Requirements Reports and War Consumables Distribution Objective to determine starter stock requirements.
2. Compares PACAF area of responsibility (AOR) requirements documents with actual swing and starter stock requirements.
3. Reevaluates current AOR prepositioning based on the two major theater war (MTW) scenario with a goal of attaining the ability to support the full spectrum of military operations to include small-scale contingencies and air expeditionary forces.
4. Recommends WRM allocation options based on the starter stock definitions and determines what could be used as swing stock for prepositioning options.
5. Same as No. 2 for the Central Command Air Forces AOR.
6. Evaluates prepositioning options suggested from the third and fourth meetings based upon risk, cost benefit analysis, accessibility, time lines, and capabilities.
7. Consolidates final inputs for presentation to the Air Force WRM Executive Review Board.

Capt Paul E. Boley, DSN 596-3535

Logistics Readiness Center (LRC) Baseline
LX199726600—Improvement Study

1. Determines a concept of operations for LRCs supporting expeditionary forces.
2. Determines LRC interfaces at different levels and with different organizations.
3. Establishes guidance for roles and responsibilities at each level.
4. Determines system requirements.
5. Determines functional roles, responsibilities, and training requirements.
6. Identifies needed improvements in modeling and simulation, exercises/wargames, contingency support, systems support, and operations/joint logistics interfaces.

Capt Paul E. Boley, DSN 596-3535

21G Pamphlet
LX199833500—Improvement Study

Develops a brochure/pamphlet to market the logistics plans officer career field to officer candidates.

Capt Timothy W. Gillaspie, DSN 596-3535

Logistics Officer Career Handbook
LX199833501—Improvement Study

1. Develops a logistics officer handbook that outlines career opportunities, education and training, and potential career paths open to logistics officers across all 21XX Air Force specialty codes.
2. Explains cross-functional matters to logistics officers, including the cross-flow program, career broadening, joint service opportunities, and any other nontraditional opportunities for logisticians.
3. Cross-references joint, professional continuing education, professional military education, and specialty courses open to officers, including descriptions and target audiences.

Capt Timothy W. Gillaspie DSN 596-3535

Survey of Legacy and Future Logistics Modeling and Simulation (M&S) Systems
LX199830100—Improvement Study

1. Conducts a survey of all current logistics models and tools; determines the best of breed.
2. Groups models and tools into tool kits that meet the M&S analysis, training, and acquisition objectives.
3. Ensures logistics requirements are included in major future M&S efforts: National Air and Space Model/Joint Simulation System, Joint Warfare System, and Joint Modeling and Simulation System.
4. Gathers M&S requirements.
5. Provides requirements to model developers in a usable format.

Capt Patrick C. Walker, DSN 596-3535

Global Engagement IV
LX199902001—Improvement Study

1. Identifies disconnects between expeditionary airpower capabilities and *Joint Vision 2010* operational concepts.
2. Explores warfighting concepts on a level playing field.

Capt Paul E. Boley, DSN 596-3535

Focused Logistics Wargame
LX199902002—Improvement Study

Assesses joint logistics capabilities and the Services' abilities to support Joint Vision 2010 tenets.

Maj John A. Bolin, DSN 596-3535

(*Seamless Supply*, continued from page 3)

In addition, a significant number of SBSS requisitions are submitted off line and thereby bypass SBSS edits. AFMC has steadfastly declined to enforce the RBL levels in D035A/C or even to highlight the differences.

The article (page 1) states:

> . . . a major misunderstanding concerning levels is that *a level should equate to an on-hand asset*." This is simply not true. On average, only the safety level should be on hand, and that presupposes all the assumptions made in the pipeline model are true. Serviceable assets on hand will always be less than or equal to the level and many times less than the level.

Given the SBSS n-1 reorder point policy for DLRs [depot-level reparable], it's not clear to me why the onhand plus due-in/in-transit assets should not equal the total RBL. Note that RBL computes safety levels by SRAN but does not transmit them to SBSS.

The article (page 34) says, "the assumption is made that demands are distributed based on the negative binomial just discussed." This assumption has not been validated since the early RAND/other work of many years ago. The D035C/D104 repair/usage database includes repair/NRTS actions at the SRAN/NSN level. RBL should analyze this data to determine the mathematical function that best fits the real data for each NSN. In addition, the actual data could provide the variance to mean ratio now "obtained through an empirical formula instead of using the data" (page 34).

Recent LMI [Logistics Management Agency] work (Table 5-1, AF501MR2, *Predicting Wartime Demand for Aircraft Spares*, April 1997) noted that demand patterns for DLRs are weapon system and WUC (work unit code) specific. However, the slopes (sorties versus flying hours) derived by LMI appear to be used only for RSP calculations and do not address WUC differences. Note that the LMI slopes were implemented only because the traditional flying hour approach produced unaffordable RSP costs. LMI (AF50LN1, page 11-6) also noted significant differences in demand by WUC. As a first start on WUC, the data should be grouped by the major categories of airframe, avionics, and engines.

Regarding funding and priorities, the article (page 36) says, "RBL has to assume that a part will get fixed based on a repair pipeline. In reality, some parts are never fixed because of funding and priorities or get fixed and sent to places other than the base that is next in the queue based on priorities." It turns out that some parts are bigger than some might expect.

In July 1999, 26 percent (23,110) of all AFMC due-outs were more than 180 days old. 7,841 of the 23,110 due-outs were IPG 1 (supply priority 01-03). In addition, 58 percent (1,402) of all ALC ASIs (amended shipping instructions) were more than 180 days old. 748 of the 1,402 ASIs were IPG 1 (supply priority 01-03). These due-outs/ASIs applied to 11,717 NSNs, hardly an exception. Some may not be aware that D041 ignores all due-outs at base and depot level.

D041, RBL, and EXPRESS all continue to ignore General Babbitt's policy that the MSD (material support division of the Air Force stock fund) is funded (via NRTS) for the POS segment only and that RSP shortages must be externally funded. Apparently, none of the data systems involved (D041, RBL, and EXPRESS) can identify the requirement to be externally funded with sufficient accuracy that POM [Program Objective Memorandum] action can be taken with any chance of success. Part of this is due to the continuing resistance of AFMC management to identify requirements by weapon system/user and thereby link to the POM process.

Despite all of the effort to make RBL work as advertised, EXPRESS continues to ignore the RBL (including RSP) and makes an independent estimate of future NRTS based on the MAJCOM scenario data and D041 usage factors. EXPRESS disregards the DDR (daily demand rate), PBR (percent base repair), RCT (repair cycle time), and OST data provided by SBSS to RBL and uses worldwide averages instead. The ALC-unique versions of EXPRESS ignore in-transit serviceable assets since it appears to be so inaccurate as to block repair inductions/asset allocations. Earlier work on in transits/RDOs under the Dirty Data initiative seems to have had little positive effect.

RBL (like D041 and EXPRESS) has never been validated against the real world. AFMC repair sources continue to repair items not required to fill RBL levels and to avoid repairing those that are required. For the GAO C-5 NSNs, 1,874 of 2,073 assets (90 percent) in work are excess to RBL levels. The cost to repair these excesses is $14.4M. Reparable assets already at the ALC represent 419 (55 percent) of the RBL deficit of 755. AFMC continues to waste SMAG [Supply Management Activity Group] transportation funds and base manpower against premium goals items that are already clogging up ALC reparable warehouses.

It's time to integrate the DLR requirements/distribution/funding processes and stop the current chaotic approach that wastes so many resources. I recommend the following:

- RBL should use the EXPRESS scenario and independently derived factors for each SRAN/weapon system/NSN to estimate NRTS and allocate requisitioning objectives to the applicable SRANs. In addition, RBL should identify assets available for redistribution and pass them to D035A for execution. RBL should recompute each 2 weeks (the EXPRESS scenario cycle) and each quarter (when new factors are available from D035C).
- D035A should enforce the RBL ROs [requisition objectives] by canceling all requisitions (except AWP/MICAP) that are not consistent with the RBL ROs as well as those that are more than 2 days old upon receipt.
- The Data Warehouse version of D035C should retain DAC data by SRAN/SRD/WUC/NSN and provide it to RBL. In addition, the scope of SBSS RAMP [Recoverable Assembly Management Processing] reporting should be expanded to provide SBSS visibility of in-transit due-ins and base MICAP/AWP [awaiting parts] due-outs to provide for cross-checking with D035 totals. Aggressive follow-up by D035C is essential to resolving in-transit and RDO mismatches.
- EXPRESS should dynamically assign RIMCS [Reparable Item Management Control System] priorities so that only reparables in short supply are given premium processing/transportation. In addition, EXPRESS should estimate NRTS/allocate repair output using the same data/logic as RBL.
- The LMI work (AF50LN1) on using sorties versus flying hours to predict aircraft spares demands should be institutionalized as part of the AFMC demand analysis process. Since it's SRD driven, it should be the responsibility of the SPDs [system program director]/single managers rather than the NSN-bound supply chain managers.
- Note that LMI found "only a small percentage of SBSS demands could be matched with CAMS [core automated maintenance system] maintenance removals" and, therefore, used unscheduled CAMS removals for their analysis. That suggests a major weakness in the SBSS/CAMS interface. It also points up the vulnerability of the current total reliance of SBSS/RBL/EXPRESS/D041 on SBSS demand data.
- I was surprised to find no analysis of the extent or effect of cannibalizations in either LMI report. Given the current emphasis by the users on reducing cannibalization rates, some explicit consideration

should be given to stockage policies that minimize cannibilization for selected items.

The ultimate goal must be to dynamically reallocate levels and assets to meet AEF [Air Expeditionary Force]/other needs using the best of the processes now available with maximum cross-checking of the related data across functional stove pipes.

I'm retired Air Force/retired contractor and am not looking for work. My goal is to provoke some serious high-level discussion leading to a chain-saw rather than sandpaper approach to supply/maintenance/transportation system integration. The last thing needed is a defense of the status quo or more reports that our people don't have time to read or to take corrective action.

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(*F-15 Support Analysis*, continued from page 5)

In effect, single string risk cuts off resupply while a tester is down, while OST risk lengthens the pipeline. The severity of the effects of subpar OST and retrograde performance depends on how actual resupply time differs from the assumptions used to plan Readiness Spares Packages.

Support Option Advantages and Disadvantages

The *current decentralized system*, in which the AIS deploys to FOLs, has the advantages of low relative cost, greater certainty in resource requirements, and an existing infrastructure. Its disadvantages, however, are precisely the difficulties that have led to examination of alternatives and have caused many deploying units to modify their procedures informally.

Personnel under the current system are likely to face continued, frequent deployments, further contributing to retention problems among avionics technicians. Further, to meet operational objectives, the current structure requires more highly skilled personnel than are currently available in the Air Force. Besides the deployment of personnel, the current system of AIS deployment consumes valuable initial airlift space that might otherwise be used to close additional forces. When the AIS is deployed in a single string for small-scale contingencies, as specified by current doctrine, LRU resupply faces a high tester downtime risk.

Modifying the current structure to eliminate AIS deployment—or the *decentralized no deployment* option—eliminates the personnel deployment and airlift requirements. Moving to this system would be relatively easy since no new infrastructure would be needed, although an increase in the serviceable inventory of spare parts would require a one-time investment that makes this structure more costly than the current structure. The risk for this structure would be in resupply from CONUS.

Consolidated structures also reduce the personnel turbulence and deployment footprint concerns associated with the current structure while being cost competitive with the current structure. Like the decentralized no deployment option, consolidated repair depends upon consistently available transportation, but its transportation requirements are limited to shorter intratheater lift and present less management complexity.

Conclusion

This article focuses on *pure* structures to emphasize trade-offs created by the alternatives. The pure models help illustrate the sensitivity of the system to individual design parameters. From the pure models, Air Force logistics personnel may be able to develop hybrids, capturing the advantages of different structures to create even better alternatives or to improve implementation feasibility.

In fact, the 48th Component Repair Squadron at Royal Air Force Lakenheath, United Kingdom, implemented a hybrid strategy to support F-15 operations against Serbia in Operation Noble Anvil (ONA). Building upon their experience providing partial support for AEF operations in Southwest Asia (SWA) over the last 5 years, they supported initial F-15 ONA operations in Europe and continuing operations in SWA from Lakenheath with their existing assets. When deployment plans for additional aircraft were projected to exceed their support capabilities, they developed an augmentation plan with CONUS organizations. This plan, executed for logistics support even though the conflict ended prior to the deployment of the additional aircraft, cut airlift footprint and deployed personnel by more than 50 percent than would have been necessary had support deployed to the FOLs. In the long run, this method would reduce the additive spare parts requirements of consolidation, because it does not lengthen the peacetime pipeline. This hybrid plan struck a balance between the benefits of consolidation and decentralized support. For example, about half of the deployment airlift benefit was achieved with just a small increase in spare parts levels.

This is representative of the decision making needed to make the EAF work. First, the Air Force must determine how it values the AEF logistics metrics. Then, it should choose ACS options that best strike a balance between these values. The Lakenheath example provides an option with some reduced airlift and a limited increase in spare parts requirements, while a permanent FSL would further reduce airlift but require more spare parts (and fewer personnel).

The Air Force should carefully examine this ad hoc planning and implementation, which served as a concept test, as well as similar events occurring for other contingencies and for other commodities. Then, the Air Force should select and begin implementing its doctrine of the future. Thorough peacetime planning will allow a more seamless, effective transition to wartime operations.

Notes

1. Gen Michael E. Ryan, "Aerospace Expeditionary Force: Better Use of Aerospace Power for the 21st Century," Briefing, Washington DC, HQ USAF, 1998.
2. The AEF is based on the "Air Force Vision to organize, train, equip, and sustain itself to provide a rapidly responsive, tailored aerospace force for 21st century military operations." Its purpose is to improve response speed and flexibility while decreasing deployment strain for a CONUS-based Air Force. The AEF will organize the Air Force into ten virtual AEFs comprising combat, mobility, and support resources that joint force commanders can tailor to specific missions. Each of the five mobility wings will be paired with two AEFs and be on call with their AEFs. AEFs will operate on a 90-day *on-call* window once every 15 months. This should provide more personal stability for deploying personnel. Maj Eric Schnaible, "AEF Implementation," Briefing, Washington DC, HQ USAF/XOPE, 1999.
3. Robert S. Tripp, Lionel A. Galway, Paul S. Killingsworth, Eric Peltz, Timothy L. Ramey, and CMSgt John G. Drew, *Integrated Strategic Support Planning for the Expeditionary Aerospace Force*, RAND MR-1056-AF, Santa Monica, California, January 1999.

4. Application of Military Standard Composite Rate Acceleration Factors for Fiscal Year 1998, AFI 65-503, *Cost and Planning Factors*, Table A32-1, 23 April, 1998.
5. Manning Statistics by (Grades 33-39) HQ ACC/DPAA, July 1999 (Provided authorized and assigned numbers for each AIS).
6. An 8-year net present value of personnel costs is used, because test equipment is estimated to have a life-span of 8 years.

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(*A Vision for Agile Combat Support*, continued from page 8)

analytical framework introduced here needs to be expanded and linked with methods for taking additional issues into account. The primary focus should be on areas of vital US interests that are under significant threat (Figure 4 shows clusters of FOLs in Korea, SWA, and the Balkans).

This potential structure and the key findings depend on the current force and support processes. As new policies are developed and implemented; the Air Force gains experience with expeditionary operations; and new technologies for ground support, munitions, shelter, and other resources become available, the system will need adjustment to reflect new capabilities. Improvements in transport times, weight, and equipment reliability may favor greater CONUS support and shrinking the network of FSLs.

An analytic framework helps focus research and attention on areas where footprint reductions could have big payoffs. Munitions is a key area where reductions in weight and assembly times could pay big dividends in deployment speed. For operations at bare bases, where shelter must be established, the development and deployment of more lightweight shelters (for example, the small shelter program or AEF hotels) can also pay dividends in deployment speed and footprint. Changes in these areas will not be made immediately, but the structure outlined previously will enable expeditionary operations in the near term.

Peacetime cost is important for the analysis. The new support concept may help contain costs by consolidating assets, reducing deployments for technical personnel, using host-nation facilities, and possibly, sharing costs with allies. Considerable infrastructure, including buildings and large stockpiles of war reserve materiel, may already be available in Europe.

Limited testing of the envisioned ACS occurred during ONA. Before the war, the United States Air Forces in Europe, Director of Logistics (USAFE/LG) consolidated WRM storage at Sanem, Luxembourg. During ONA, the USAFE/LG established consolidated repair facilities at Lakenheath and Spangdahlem. An intratheater distribution system was created to provide service between FSLs and FOLs. Munitions ships designated for use in another AOR were moved to support ONA munitions resupply. This transfer of assets between theaters raised several issues about how non-unit resources should be stored for use in multiple AORs.

ONA raises several general issues for those designing the future ACS system. Support design for ONA took time that may not always be available in other conflicts or war. Heroic efforts were required to overcome system, training, and concept of operation shortfalls. This raises questions as to what new efforts should be institutionalized in an ACS system. Some resources needed for ONA were tied to other AORs, and this leads to questions about logistics support becoming more of a strategic, rather than a tactical, asset.

Strategic and Long-term Planning for the ACS System

Building an ACS system requires many decisions about prepositioning and the location of support processes, including the categories of FOLs and FSLs. The prototype models developed and used deal with process characteristics and rough costs, but support decisions must also account for threat situations and political considerations that change over time.

Strategic planning for an ACS system must be global and evolving. A global perspective is needed because the combination of cost constraints, political considerations, and support characteristics may dictate that some support for a particular theater or subregion be provided from facilities in another region.

This is not a theoretical point. Much of SWA is politically volatile, and support there might better be provided from outside the region, as indeed, some is now from Europe and Diego Garcia. The configuration of FOLs and FSLs is critical in sizing the aircraft fleet and in setting up its refueling infrastructure to support all theaters.

Strategic planning must be evolving because the new security environment includes small, short-notice contingencies and continually changing threats. Geographic areas of critical interest will change over time, as will the specific threats within them. An expeditionary ACS system designed today would be oriented toward SWA and Korea, but within a decade, those regions could be at peace and new threats emerge elsewhere.

In addition to political changes, support processes and technologies may also change as the Air Force continues to move to a more expeditionary footing and seeks to reduce support footprints while maintaining effectiveness. Over the next 10 years, it is expected that many process and technology changes will force reevaluations of the ACS system.

The need for global and evolving planning will require centralized planning in which cost, politics, and effectiveness trade-offs are made for the system as a whole and to ensure that each theater is appropriately protected and supported. This goes against the current practice of giving each theater commander control of all theater resources. Peacetime cost considerations alone require that facilities not be duplicated unnecessarily across theaters.

Changes in the force structure will also require changes to the support structure. The F-22, for example, is designed to have one-half the support footprint of the F-15. The Joint Strike Fighter is also designed to reduce support requirements. Air Force wargames, particularly the Future Capabilities games, have experimented with radically different forces relying on standoff capabilities or space-based weapons. All of these developments will lead to changes in both support requirements and in the options that are most attractive under peacetime cost constraints.

The advantage an analytic framework is such long-term changes can be handled in the same way as short-term modifications to policy and technology. New technologies, political developments, and budget changes require continual reassessment of the support system configuration, which we are designing our model to do. New force structures will require different support resources, in turn, requiring new support structures. For long-term decisions, the ability to perform quick-turn, exploratory analysis of different support structures becomes even more important.

Notes

1. A Logistics Transformation Team, comprising Air Force and KPMG personnel, is leading much of this transformation work. The Logistics Transformation Team was previously the Agile Logistics Team, which was previously the Lean Logistics Team. Electronic correspondence from Lt Col Michael Menendez, HQ USAF Installations and Logistics, Logistics Transformation Team, to Robert S. Tripp, RAND, 5 October 1999.
2. For a detailed discussion of how changing technology affects one part of the support system, see "F-15 Support Analysis," page 2, of this publication.
3. For a more general discussion of this point, see Robert S. Tripp, et al., 1999, "Strategic EAF Planning—Expeditionary Airpower, Part 2," *Air Force Journal of Logistics*, Vol 23, No. 3, 4-9.
4. We again direct the reader's attention to page 2 of this publication for a more specific discussion of trade-offs regarding one part of the support process.
5. This model is discussed in more detail in Tripp, et. al.
6. Air Force Materiel Command Material Handling Engineering Program Office Briefing, Wright-Patterson AFB, Ohio 6 July 1999.
7. See page 2 of this publication.
8. Amatzia Feinberg, et al., Supporting Expeditionary Aerospace Forces: A Preliminary Analysis of LANTIRN Options, RAND AB-293-A, Santa Monica, California, 1999.
9. Data collected from the 4th Air Expeditionary Wing deployment to Doha, Qatar, from May 1997 to August 1997. MICAP requisitions that were processed at Prince Sultan AB in Saudi Arabia averaged less than 5 days. At that time, Prince Sultan AB and Doha were connected by scheduled military resupply flights.

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(*AEF Munitions,* continued from page 14)

munitions activities. This is a well-documented concern. In 1960, the railroads maintained 217,552 miles of rail track. By 1996, this mileage was reduced to 120,000 miles. Most of the reduction came from the elimination of branch and feeder lines similar to the ones that support military installations.[10] In addition, the movement of 20-foot ammunition containers requires railcars specifically designed for these containers. The total 20-foot railcar slot availability in the United States is 149,000 slots. However, since federal regulations require railcars moving ammunition to be equipped with either steel decks or *spark shields*, only 28,000 slots are usable for munitions. Since the railcars would have to pulled from commercial service, emptied, and diverted to remote Army depots for loading, significant shortfalls and delays are anticipated.[11]

During Desert Storm, munitions movement was hampered, because stock record account numbers for deployed assets were not established at the start of operations. This allowed pallet after pallet of materiel to be frustrated because destination guidance was absent. Lack of en route visibility can further complicate this problem. According to a 1998 audit by the Air Force Audit Agency, 10 out of 12 installations lost visibility and accountability of munitions due to a lack of interface between munitions and transportation information systems.[12] To meet the fast-paced timing of the AEF, both of these problems must be resolved.

Another munitions movement concern is the growing congestion at sealift ports and the required synchronization to process and move assets through port facilities. Because of the dramatic increase in the intermodal cargo business, port authorities often find it difficult to ensure the availability of port facilities for military deployments. Commercial shippers are encouraged to sign long-term leases with port authorities to capitalize the investment in the port infrastructure. Thus, open storage areas of the past, which were used in munitions operations, are now filled with containers.[13] These open areas remain critical to munitions operations, since separation of containers may be required for explosive safety reasons. Deploying munitions by ship becomes more complicated because only a limited number of ports are certified to handle explosives in the United States. They include Military Operation Terminal, Sunnypoint, North Carolina; Concord Naval Weapons Station, California; and Port Hadlock, Washington. Currently, each of these ports requires infrastructure upgrades to attain the throughput necessary to support potential operational requirements. These upgrades are currently budgeted by the Military Transportation Management Command and are critical to ensuring the ability to move Air Force munitions from the United States by sea. Maintaining an efficient munitions movement at a sealift port can also be a difficult task. Port synchronization is a fine art that is usually not practiced except during actual contingencies. The US Transportation Command is trying to include port synchronization in military exercises via Turbo CADS. These Joint Chiefs of Staff-funded exercises test the DoD ability to transport munitions in 20-foot containers on commercial vessels and have led to the purchase of additional pier and munitions facilities and equipment.[14] Funneling supplies through a port requires a high level of synchronization and capacity balancing to achieve optimal throughput. Each step of port operations is closely linked and can become a bottleneck. Cranes for off-loading become critical paths for achieving high productivity. Communication between port officials is critical, and the lack of manifests and stowage plans can negatively impact the speed of an off-loading operation. In addition, at foreign locations, the availability of the deep-water berths required for most munitions-laden ships is a major consideration. Also, foreign ports usually lack explosive siting and the ability to store large quantities of explosives. Therefore, a ground transportation plan must be established to rapidly move munitions from the foreign port to its final destination. Currently, we rely on *capturing* the host nation's trucking infrastructure through contracting actions to move munitions by ground. In some countries, this can be problematic. For instance, practicing Muslims will not drive on Thursday and Friday. Also, moving property, especially munitions, across borders may require diplomatic involvement that can take weeks to complete. Additionally, limited road networks and weather may cause intertheater trucking to come to a halt.[15]

Munitions Planning Problems for the EAF

EAF planning must recognize that programs such as STAMP and APF bring only limited capabilities to a conflict and do not provide an unlimited supply of preferred munitions to support an AEF. Currently, the Air Force does not have a written munitions concept of operations (CONOPS). However, USAFE has recommended that the Air Force develop a detailed munitions CONOPS with a coordinated positioning strategy.[16] In addition to the CONOPS problem, at present, no sourcing restrictions are placed on filling legitimate theater requests for STAMP. This means that munitions packages are shipped on a first-come first-served basis and, if more than one conflict arises in a short period of time, munitions availability to one theater could easily be limited because of another theater's requests.

The munitions operations at both Hill and Medina have the capability to deliver STAMP packages to their own flight line much faster than airlift can be provided to move them. Often, the STAMP packages wait many days for airlift.[17] This means relying on STAMP for the initial combat sorties at a new combat location may not be feasible in the current environment and with current airlift availability. Also, even when munitions packages are effectively airlifted to a forward operating location, there must be trained munitions technicians available with forklifts, loaders, lifts, and other handling equipment to assemble and load munitions packages. All-up-round (AUR) munitions containers for weapons such as the AGM-130 are not easy to handle, and most Air Force laser-guided munitions still need to be assembled prior to delivery to combat aircraft. If the timing for the arrival or delivery of these logistics pieces (assets, equipment, and trained people) is wrong, it can put a quick stop to combat sorties needed for the first 48 to 72 hours of a conflict. Finally, at Medina, the privatization of Kelly AFB, an aging munitions infrastructure, and current runway restrictions for airlift aircraft make the future of that STAMP location uncertain.[18] With the development of the EAF concept, the Air Force needs to consider the future of the STAMP program and how it could be improved to better support the rapid supply of munitions to a deployed AEF.

Munitions support from an APS is limited and is directly tied to sealift. The first consideration for an APS or any ship carrying munitions should be its protection as it transits to combat areas. When the United States begins sealift of military resources to a conflict, including munitions, the chokepoints through which the cargo flows must be protected. There are at least seven chokepoints considered vital by the DoD.[19]

- The Gulf of Mexico-Caribbean Sea with the Panama Canal.
- The North Sea-Baltic Sea with several channels and straits.
- The Mediterranean-Black Seas with the Strait of Gibraltar.
- The Western Indian Ocean with the Suez Canal, Babel Mandeb, the Strait of Hormuz, and around South Africa to the Mozambique Channel.
- The Southeast Asian Seas with access to Japan, Korean, China, and Russia.
- The Southwest Pacific with access to Australia.
- The Arctic Ocean with the Bearing Strait.

To use one of the APS, a CINC most likely has to wait several days as the APS sails to its destination port—assuming that it is not delayed in one of the chokepoint areas. Once an APS is tasked for use, a port with sufficient depth and equipment to handle the ship must be located. In addition, explosive siting requirements must be met, and sufficient ground transportation must be coordinated to ensure off-loaded munitions can be moved from the ship to the final forward operating location without major disruption of the port operation.

Requirements at the combat location itself can also create additional mission shortfalls. During logistics planning for an operation, the factors limiting logistics velocity at the reception base and prior to employment must be addressed. These include storage space, net explosive weight restrictions, and the standard conventional loads. Currently, each unified commander's needs in these areas are different, and prepositioning is complicated by lack of standardization. Munitions preferences are driven by planners, operators, theater restrictions, munitions assembly requirements, and trade-offs between different weapons. Also, unit preference remains a driver in the choice of munitions. Pacific Air Forces is the exception to this observation. This command has tried to follow central target planning and munitions allocation with the best available weapon for many years. Obtaining uniformity in these areas and optimizing the selection of munitions for the target assigned to deploying aircraft would yield higher productivity and a reduced logistics footprint.[20] This point is reinforced by the Gulf War Airpower Survey that states, "we must reduce the *kitchen sink* attitude of the operations planners, and preplan the target set and munitions required."[21] Since that statement, HQ USAF has gone to great lengths to develop programs to integrate the nominated target sets, preferred munitions requirements, and the CINC sortie allocations.

Current Efforts and Recommended Changes

To meet the munitions challenges of the EAF, the Air Force must look for ways to improve rapid transportation capabilities, infrastructure, and prepositioning support. Currently, PACAF maintains the TARRP program, and the STAMP and APF programs provide a limited munitions swing stock capability. However, other efforts are underway to improve munitions logistics in the Air Force. In USAFE, plans are underway to develop a rapid air packages program near Ramstein AB, Germany. This program, the Rapid Air Munitions Packages-Europe (RAMPE), will be similar to the STAMP and TARRP programs and will provide USAFE with a similar capability for moving munitions by air to support a pop-up AEF and ongoing contingencies.[22] Current plans call for existing munitions stocks in USAFE to be consolidated at an Army ordnance area near Ramstein AB and then transported anywhere a conflict arises in Europe. In addition to this effort, the Military Sealift Command is considering contracting an additional (fourth) APS.[23] These initiatives are a good step toward supporting the unpredictable nature of an expeditionary air force and may only be the beginning of a much larger effort.

Based on the need for a more responsive munitions logistics capability, the Air Force should also consider these additional recommendations. First, the future and infrastructure of the current STAMP units need to be considered. These units have the ability to move munitions by air during the opening days of an AEF. However, a limited size and deteriorating infrastructure make STAMP a minor tool for the AEF. Improvement and expansion of the role of these units should be considered.

Second, munitions flights and squadrons around the world should have the necessary equipment (chains, binders, 463L pallets, dunnage, and so on) on hand in the munitions storage area to be able to react to shipping notifications to support a pop-up AEF in the surrounding region. In addition, munitions palletization training for munitions personnel needs to be added. Some squadrons may even need to consider having a STAMP section that can easily lead the effort during a crisis. A further catalyst for these efforts would be the addition of palletization training for munitions personnel while attending the Air Force Combat Munitions Assembly Course. Worldwide standardization of munitions packages and palletization procedures would reduce the learning curve during a crisis and ensure combat units receive effective munitions packages regardless of where they come from. This standardization might be obtained in the form of a palletization handbook or a technical order to provide munitions personnel with an immediate source of information for moving munitions in a crisis. These actions could serve as a relatively simple starting point in ensuring readiness for a major AEF tasking.

Third, munitions logisticians must continue to move the Air Force toward new munitions systems that are less logistically intensive. Storing and delivering weapons in AUR containers, building miniature munitions, and using insensitive explosives have the potential to reduce the difficulty involved in munitions logistics. In addition, procuring lighter equipment such as the multipurpose bomb trailer and loader should be pursued along with a multipurpose common munitions tester.[24] Each of these advancements will reduce the footprint for munitions and increase our ability to effectively support an AEF.

Fourth, theater logisticians need to identify how to get munitions to the most remote spots where an AEF might deploy within a theater. Once the possible munitions pipeline is identified, they can more accurately inform the CINC as to munitions availability and sustainment at the AEF location. This process will involve a great deal of forward-basing research and preplanning for using alternate modes of transportation (rail, water, and truck). Through this planning process, the Air Force will hopefully be able to identify how to construct an optimum web of rapid response munitions support locations—such as STAMP, TARRP, and RAMPE—that can cover a possible conflict anywhere in the world. Building this web will mean adding munitions storage areas or upgrading old facilities. This effort could help counter the deteriorating munitions infrastructure worldwide and provide an increase in the Air Force's rapid response capability to support an AEF.

Finally, a joint National Inventory Control Point for munitions could set worldwide inventory controls and set priorities on munitions shipments. Such an organization could not only control a worldwide web of munitions locations but also streamline the ability to receive munitions support from the other Services. Such an organization might also prove more effective in coordinating the reallocation of munitions from one theater to the next to support an AEF at a new crisis location.

It is naive to think we can provide a sustained flow of munitions by air anywhere on the globe in a handful of hours. However, through proper preparation, prepositioning, training, and planning, the Air Force can obtain the munitions availability to support the EAF concept anywhere in the world. It will be up to the logistics communities in each theater to determine how they will establish a munitions pipeline for possible warfighting locations in theater. Then the Air Force should move to proactively construct a munitions infrastructure, prepositioning plan, and transportation plan that address the shortfalls in these pipelines before the start of an AEF, not when the conflict has already begun.

Notes

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(*From Extreme Competitive Advantage to Commoditization*, continued from page 27)

economic base; few countries can afford to *build* their own version of the AMARC.

With SF^3 technology, the materials used in today's aircraft can literally be ground into powder at the end of an aircraft's service life and recast using tomorrow's designs. Even using scarce, state-of-the-art materials, nations can have a rapidly evolving fleet of weapons by simply recycling older systems. Airframes will no longer have to be designed with 20- to 50-year life cycles to be cost effective. Given the minimal cost to reproduce products with SF^3 technology, weapon systems could be designed to last only a few months. Reclamation creates a virtually unlimited supply of raw materials, thus eliminating another barrier that currently protects the US military's ECA. To the extent that other nations can obtain the necessary designs, even the production of very high-tech shapes could become a commodity business. SF^3 might allow virtually any country to produce nearly any shape at will, but more important, given the availability of the design codes and the ubiquity of SF^3 technology, complex defense products could be transformed into mere commodity items.

Addressing the Threat

SF^3 has the potential to destroy significant aspects of the US national defense ECA overnight. In Schumpeterian fashion, this radical technology could destroy the current industry structure. SF^3 could redefine much of the military conventional wisdom regarding logistics. History teaches us that it is not enough to just field innovative and technologically superior weapons systems. For example, in World War II, although the Germans had the technology to develop the Tiger tank and the ME-262, they were unable to field enough systems fast enough to make a significant difference in the outcome of the war. The necessity to maintain a competitive advantage in SF^3 production technology would require that the United States rely more heavily on the commercial sector for the development and manufacturing of weapon systems. This seems to align with the current trends within military procurement policies.

Given the analysis of the changing nature of defense manufacturing processes and the potential impacts on the US military, it is important to move beyond the two popular models of strategy and find a way to address the possibility of *creative destruction*. One place to find such rigor is in *Game Theory*. Recent research in game theory describes how organizations can systematically analyze and predict the behavior of players engaged in formulating strategies to gain competitive advantages.[20] Given a set of conditions, such as the introduction of SF^3 technology, they show how managers can play to win, even to the extent of changing the game where possible. Note that researchers like Schumpeter point out that the game is an ongoing process; others will be trying to change the game as well. Sometimes the competition's changes will work to an organization's benefit, and at other times, the results will be less than favorable. Thus it is important that attention from all levels be given to the onset of SF^3 technology to determine the optimal manner in which to play the *new game*.

It is clear the defense industry cannot simply hide from the problem. Unlike IBM's reaction to the development of personal computers and the personal computer market, the defense industry must embrace this new technology. However, being the first mover probably would not be necessary. Prior research into technological first moves shows that disadvantages accrue about as often as advantages. Therefore, unless there are clear first mover advantages, organizations should develop a fast second mover capability. Thus, the military must closely monitor SF^3 and be ready to be a fast second mover.

In terms of changing the game, if the United States focuses on other advantages, its ECA may continue. However, both the vision and mission must transition from one of a world-class manufacturer to that of a high-tech architect and engineering environment, designing weapon systems optimally adapted to the environment of the current threat. For example, the United States might surrender its advantages in terms of economies of scale and increase its emphasis on research. The advantage in defense would then shift to *technogenetists* and information technologists capable of understanding the requirements and complexities of specialized environments. Using algorithms based on Darwinian principles, airframe designs would continually evolve via mutation in response to environmental inputs. The software could actually *learn* and decide the best parameters and design characteristics to employ. Current aircraft designed to optimally satisfy particular missions and operations would form the basis of next generation designs suited for specified environments.

Conclusion

While adapting to significant technological breakthroughs and understanding the evolving competitive landscape becomes a prerequisite for modern organizational survival, for a nation, the stakes of losing ECA are much higher. Technological breakthroughs like SF^3 offer the potential for tremendous change in the defense landscape. It could diminish many of the advantages currently enjoyed by the United States on the battlefield and potentially lead to the commoditization of weapons production. In addition, any competitive advantage offered by new designs could be extremely short-lived. This article focused on three dimensions that demonstrate the potential revolution offered by SF^3: decentralization, mass customization, and reclamation. Clearly, there are many others. As SF^3 and other dramatic technologies become reality, it will become increasingly more important to identify further dimensions upon which radical change can be expected.

The large aren't eating the small, but the fast are eating the slow.[21]

Notes

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