Selected Readings and Analysis **Today's Logistics**

Today's Logistics *Selected Readings and Analysis*

Today's Logistics

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Introduction

Logistics has proven to be the key element in 20th century warfare; however, it has also proven to be an element that was often not adequately documented or understood.

Tomorrow's warriors will have to relearn the things that today's warriors have forgotten.

—General Billy Minter, USAF

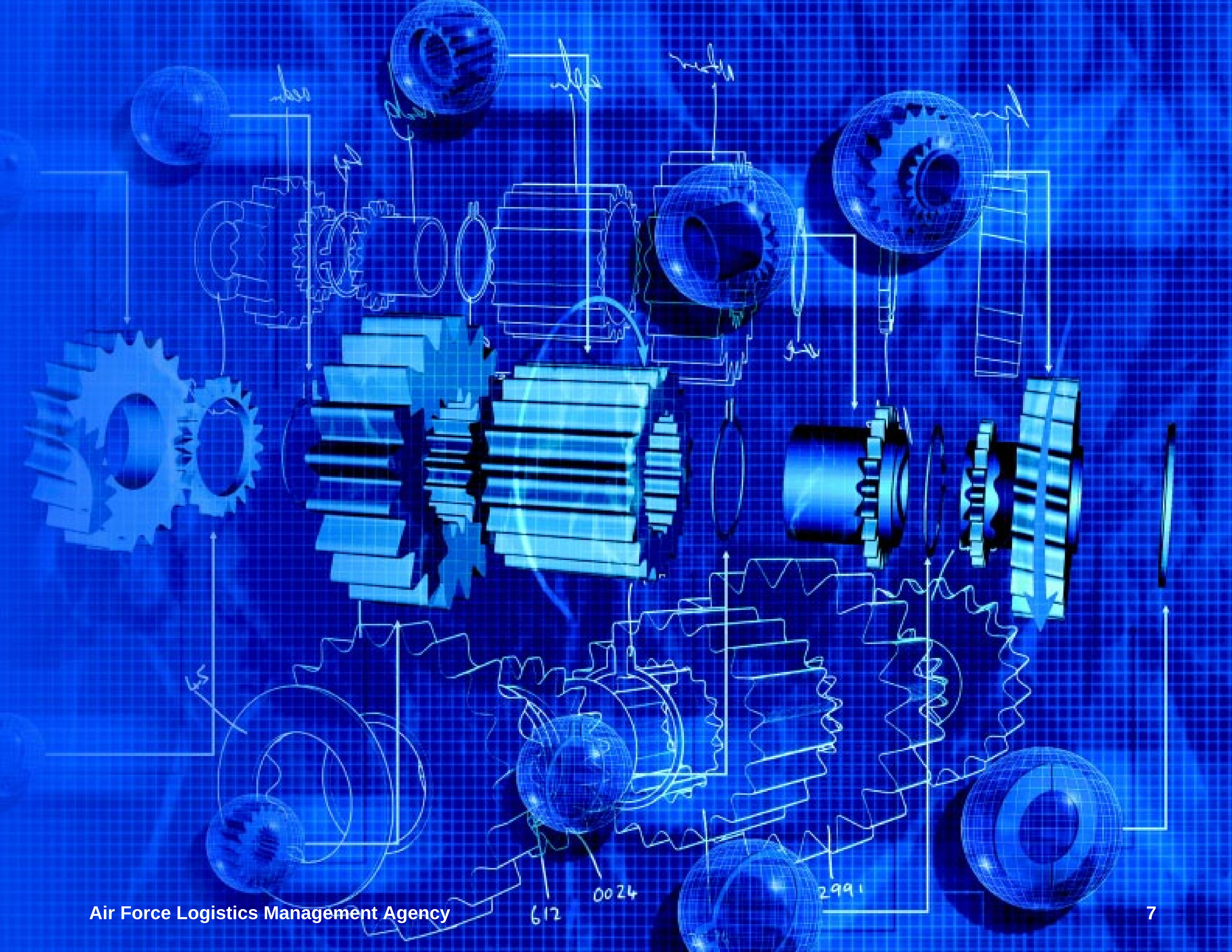
I have no reason to believe that logistics will ever have much military sex appeal, except to serious soldiers . . . .

—Major General Julian Thompson, Royal Marines

What is Logistics?

The word logistics entered the American lexicon a little more than a century ago. Since that time, professional soldiers, historians, theorists, and business experts have had a great deal of difficulty agreeing on its precise definition. Even today, there is disagreement about what constitutes logistics, in spite of its frequent usage in official publications, military service and joint regulations, textbooks, and magazines.

Jomini observed that logistics is "the practical art of moving armies." He spoke further of "providing for the successive arrival of convoys" and establishing and organizing . . . lines of supply."[1] From this, it can be said that logistics is the practical art and process of moving military forces and keeping them supplied. Arriving at an understanding of the problems involved in supporting military forces as affected by changes in technology, organization, world geopolitics, and many other relevant factors is essential. Likewise, so is gaining some level of understanding concerning the effect logistics has on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strategy—to include the various levels of wartime strategy, as well as peacetime planning and organizational strategy.

"Strategy, like politics, is said to be the art of the possible."[2] However, what is possible is not something based solely on weapons platforms, numerical strength, tactics, or doctrine. Rather it must take into account what Martin van Crevald called the hardest facts of all: those concerning requirements for supplies available and expected, organization and administration, transportation, and arteries of communication.[3] In today's rapidly changing global environment, the strategic decisions made concerning logistics during peacetime may prove to have a greater effect on what is possible during crisis or wartime than at any other time in history.

Eminent historian Stanley Faulk defines logistics on two levels. First, at the intermediate level:

> . . . logistics is essentially moving, supplying, and maintaining military forces. It is basic to the ability of armies, fleets, and air forces to operate—indeed to exist. It involves men and materiel, transportation, quarters, depots, communications, evacuation and hospitalization, personnel replacement, service, and administration.

Second, at a higher level, logistics is the:

> . . . economics of warfare, including industrial mobilization, research and development, funding procurement, recruiting and training, testing, and in effect, practically everything related to military activities besides strategy and tactics.[4]

Stephen Hays Russell, in one of the articles that follows in this book, suggests a new logistics paradigm—one that accounts for the many facets of logistics. Dr Russell suggests that the various practices comprising logistics, when taken together, define logistics. In his paradigm, logistics has four subdisciplines:

- Military
- Business
- Event
- Process

An analysis of these four segments of logistics practices suggests that logistics is customer service, relates to developing capabilities and managing activities that focus on meeting support needs, and involves logic and calculations. A general theory of logistics then results: logistics is the science of developing and managing the capabilities and protocols that are responsive to customer-driven service requirements.[5]

Logistics has proven to be the key element in 20th century warfare; however, it has also proven to be an element that was often not adequately documented or understood. Military professionals, historians, and theorists have been all too susceptible to the view that relegates logistics to the background of their work. A recurring theme has been the tendency for both political and military leadership to neglect logistical activities in peacetime and expand and improve them hastily once a conflict has broken out. This may not be as possible in the future as it has been in the past. A declining industrial base, flat or declining defense budgets, force drawdowns, and base closures have contributed to eliminating or restricting the infrastructure that made rapid expansion possible. The final impact of competitive sourcing and privatization (formerly outsourcing and privatization) on military strategy, force protection, and logistics support is still a matter of conjecture and debate. Similarly, the capability of just-in-time logistics to support military operations has enjoined a great deal of debate. Regardless, modern warfare demands huge quantities of fuel, ammunition, food, clothing, and equipment. All this must be produced, purchased, transported, and distributed to military forces—and of course, the means to do this must be sustained. The reality is that logistics is the primary consideration in all modern military operations—crisis, operations other than war, or war itself. Ignoring this reality or making peacetime or wartime organizational, planning, or strategic decisions without consideration of it is to do so at peril.

Military Logistics and the Post-Cold War World

The US role in the post-Cold War world has changed dramatically. Today, military forces are no longer dedicated solely to deterring aggression but must respond to and support a variety of combat and humanitarian missions. From peacekeeping, to feeding starving nations, to conducting counter-drug operations, the military must continue to adapt to evolving missions and working with a broad range of allies or coalition partners. Logistics infrastructure and processes must evolve to support the new spectrum of demands. New technological advances must be capitalized and integrated into the support infrastructure. Similarly, the logistics community must examine existing processes through a variety of studies and analysis efforts and look for ways to make quantitative and qualitative improvements. Accepted theories, practices, and processes need to be examined and, where necessary, challenged and changed. Two concepts dominate military logistics today: Focused Logistics at the joint level and Agile Combat Support within the Air Force. The vision of both of these concepts is the ability to fuse information, transportation, and other logistics technologies in order to provide rapid response, track and shift assets while en route, and deliver tailored logistics packages at all levels of operations or war.[6] This same vision includes enhanced transportation, mobility, and pinpoint delivery systems.[7]

Civilian Logistics in Transition

Over the last 40 years, logistics within the civilian sector has also changed. What began as an effort to apply the principles of military logistics to physical distribution evolved into inbound logistics (physical supply) to support production and outbound logistics (physical distribution of products or commodities) to support external customers.[8] Recently, inbound and outbound logistics have come to be viewed as part of a much larger process—supply chain management (SCM). SCM is the process of linking all businesses up and down the supply chain in a collaborative network.[9]

Military Logistics in Transition

Military logistics, at a more fundamental level, is in a period of transition brought about by the information revolution. In spite of the large sums of money expended for information systems, many challenges concerning workflow, data integrity improvement, and efficient communications must still be overcome.[10] A variety of human and cultural factors still impedes full-scale adoption of many new information technologies—complexity and difficulty in the use of some systems, loss of control, changes in fundamental power relationships, uselessness or old skills, and changes in work relationships. Further, some organizational cultures are by their very nature risk averse.

Organizational Change

Organizational change should and must accompany efforts to enhance existing capabilities or exploit new capabilities. Innovation does not always result from new technologies. Rather, it may simply be used to improve the ability to perform a particular activity.[11] The relationships among technological change, innovation, military operations, business operations, and changes in concepts and organizations are nonlinear. That is, changes in input may not yield proportionate changes in output or other dynamics.[12] Significant organizational, intellectual, and technological changes are seen during periods of transition. The major change, however, must be intellectual. Without this, innovation becomes meaningless and organizational change impossible.

Today's Logistics

Today's Logistics is a collection of essays, articles, and studies are very much about change, innovation, and finding ways to improve processes and products. The majority of the writings deal with improving specific facets of Air Force logistics: supply, transportation, maintenance, contracting, and prepositioning. However, other works have been included that focus on logistics thought, theory, crime, and history. Much of the material is based on work performed by the staff at the Air Force Logistics Management Agency.

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The views expressed in the articles are those of the authors and do not represent the established policy of the Department of Defense, Air Force, Air Force Logistics Management Agency, or the organization where the author works.

Notes

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The intensity of that war serves to underline the need for holding large stocks of expensive war materials if one is contemplating war or intending to deter a potential aggressor. Such stocks offer little appeal to most politicians with their eyes on the electorate; nor to those who wish to cut defense spending for moral or economic reasons, or, indeed, to those who wish to be seen to have their country's defense interests at heart, by building up the shop-window with men and equipment. All too often, that shop window has pitifully small stocks of war reserves behind it, simply because to cut back on the holdings of war reserves represents an easy and invisible path to economy. Yet, to deter, stocks need not only to exist but be seen to exist.

—Major General Julian Thompson,
Royal Marines

AFLMA Analysis

Senior Master Sergeant
Douglas L. Tucker

There is no simple, standard definition for *vehicle*. There is no single way to identify which vehicles are critical to the execution of a wartime or peacetime mission.

Reclassifying USAF Vehicles

Background

Detailed information about vehicles—how many are needed, who needs them, why they are needed, what shape they are in—is necessary to meet the intent of federal oversight initiatives and ensure the Air Force mission can be carried out successfully. That information is not available as it should be, for several reasons. At the crux of the matter, there is no simple, standard definition for *vehicle*. There is no single way to identify which vehicles are critical to the execution of a wartime or peacetime mission. Air staff and major commands (MAJCOM) cannot identify the types and quantities of vehicles required to meet the combat operational needs of the Air Force. This has led to proliferation of functional responsibilities; classification, funding, and management systems; and lack of overall visibility of what vehicles are needed, by whom and why.

The idea of changing the way vehicles are classified has been around for several years. Typically, discussions have centered on the registered vehicle fleet (often referred to as the *blue fleet*) and how the priority buy process does not meet users' needs. But reclassifying vehicles by simply changing names in an attempt to receive increased funding would be fruitless. Rather, classifying vehicles as they relate to mission requirements is a concept that is needed to better support today's Expeditionary Aerospace Force (EAF).

The EAF is the Air Force vision to organize, train, equip, and sustain itself to provide rapidly responsive, tailored aerospace forces for 21st century military operations. The EAF allows us to better manage the force and determine when that force is stressed and where relief should be focused. At its core, the EAF is about structural and cultural changes to create more effective force management tools. A key objective is to understand where USAF resources are limited and how overcommitting them to meet requirements today can result in less capability to meet essential requirements tomorrow.[1]

Discussion and Analysis

Fragmented Responsibility, Contradictory Classification Systems

The Air Force owns more than 102,500 vehicles valued at approximately $6.2B and depends on them to meet peacetime and wartime mission requirements. The Air Force Directorate of Transportation, Vehicle and Equipment Division is responsible for policy and guidance to ensure effective administration of the operation, maintenance, and use of Air Force vehicles. The Air Force Directorate of Supply, Combat Support Division implements vehicle acquisition and requirement policies and programs and manages the vehicle procurement program. The Warner Robins Air Logistics Center (WR-ALC), Support Equipment and Vehicle Management Directorate is responsible for worldwide, integrated, weapon system management (cradle-to-grave) of registered vehicles, and registered equipment allowances. Registered vehicles are managed through two separate automated systems: the Air Force Equipment Management System (AFEMS) and the Online Vehicle Interactive Management System (OLVIMS). These systems are used for accounting and daily management of the fleet. However, neither system accurately identifies vehicles needed for wartime missions or differentiates between wartime- and peacetime-use vehicles. The Air Force has several different means of classifying vehicles already in use. However, there does not appear to be any connection among the many agencies doing the classification, the guidelines directing it, or the systems documenting it. Therefore, many of the classification systems actually work against others, creating confusion and misrepresentation of vehicle requirements.

Because of these fragmented and contradictory management and classification systems, the best vehicle management decisions may not always be made, especially in light of the new, expeditionary nature of the Air Force, which requires deploying quickly with the right equipment. Not having an operational classification of vehicles obscures requirements, and mission impact may not be accurately conveyed to decision makers for planning and budgeting.

Figure 1 shows the major factors affecting the numerous ways vehicles are classified. The various individual factors affecting vehicle classification categories and processes do not usually take the other factors into consideration. The agencies most concerned with vehicle classification systems–MAJCOM directors of transportation, WR-ALC Support Equipment and Vehicle Management Directorate, and the Air Force Director of Transportation–have no direct input into individual vehicle classification.

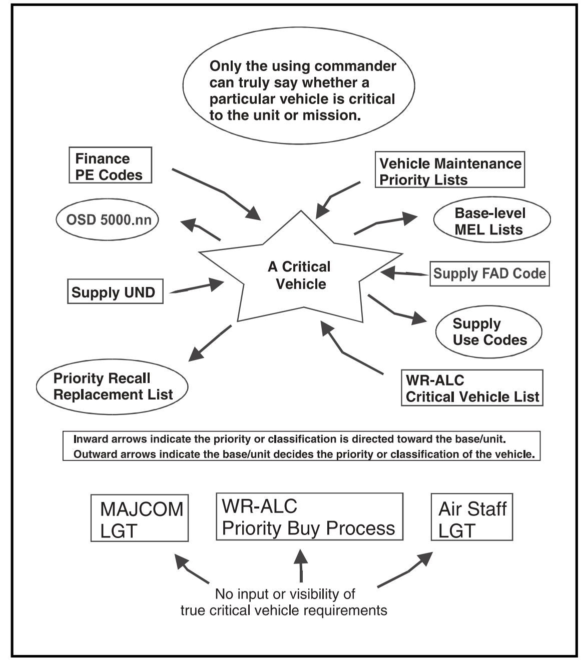


Figure 1. Factors Affecting Classification of Vehicles

What Is a Vehicle?

Before we can even discuss how vehicles are classified, we must first define *vehicle*. Various regulations and instructions define vehicles differently. According to 41 Code of Federal Regulations, *Motor Vehicle Management,* Part 102-18, a vehicle is "Any vehicle, self-propelled or drawn by mechanical power, designed and operated principally for highway transportation of property or passengers."

Department of Defense (DoD) 4500.36-R, *Management, Acquisition, and Use of Motor Vehicles,* March 1994, differentiates among motor, commercial design, nontactical, and tactical vehicles. *Motor vehicles* are designed and operated principally for highway transportation of property or passengers but do not include vehicles designed or used for military field training, combat, or tactical purposes. *Commercial design vehicles* are designed to meet civilian requirements and used without major modifications by DoD activities for routine transportation of supplies, personnel, or equipment. *Nontactical vehicles* are commercially designed motor vehicles or trailers acquired for administrative, direct mission, or operational support of military functions. All DoD sedans, station wagons, carryalls, vans, and buses are considered *nontactical*. *Administrative support vehicles* are commercially designed and used for common support of installations and personnel; these include all DoD sedans and most station wagons. *Direct mission support vehicles* are commercially designed and used by military activities directly supporting combat or tactical units or for training personnel for such activities. *Operational support vehicles* are commercially designed and used by units conducting combat or tactical operations or for training personnel for such operations. *Tactical vehicles* are designed to military specification or are a commercially designed motor vehicle modified to military specification to meet direct transportation support of combat or tactical operations or for training of personnel for such operations. The Air Force uses commercially designed vehicles in tactical roles due to the on-pavement environment of their flight lines.

However, Air Force use of commercial vehicles in tactical roles appears to conflict with the definition of nontactical vehicles since the Air Force uses carryalls, vans, and buses to transport aircrews to their aircraft. Additionally, there is no guidance on how to differentiate between tactical and nontactical commercial design vehicles.

Registered/nonregistered and *reportable/ nonreportable* are interchangeable terms used throughout many Air Force instructions and systems. These terms are ways the Air Force describes equipment items in the transportation and supply systems. For example, registered vehicles are really registered *equipment* items, and nonregistered vehicles are nonregistered *equipment* items. The term *organizational/support equipment* can also refer to many vehicles in the Air Force inventory. These different types of equipment are all *generic* vehicles.

Some vehicles are identified in Technical Order 36A-1-1301, *Vehicle Management Index File*, where all registered vehicles (budget code V) are listed by national stock number (NSN). Some nonregistered vehicles (budget code X) are also identified. However, vehicles that are considered organizational equipment and have a budget code E are not listed in this technical order. Budget codes are used for data system processing. They identify a vehicle by its associated budget program or stock fund division. A distinction is made based on the funding each receives or more directly *how each vehicle is funded* and how it is managed in the supply systems. Because of these variations, not everything that looks like a truck is a *vehicle* under Air Force vehicle management systems and definitions. Commanders at all levels struggle to understand who has responsibility over procurement, management, and maintenance of these items that are so much alike, yet so different.

Air Force Manual (AFM) 23-110, *USAF Supply Manual*, Volume II, Part 4, Chapter 3, identifies vehicles (assigned a reportable registration number) as items in federal supply groups (FSG) 23, 24, 38, and 39; federal supply class 4210; and any FSG with a material management code YW. The exception is vehicles procured in Europe and assigned command/base L numbers.

There are two common characteristics of all Air Force vehicles, regardless of who manages them or how they do it: they should all be accounted for in AFEMS, and they all operate on the ground, either self-propelled or pulled by a powered item, to perform a specific function or mission while transporting personnel, equipment, or cargo.

Many people believe scooters and riding lawn mowers should not be considered *vehicles* because they do not transport personnel or cargo. However, people sitting on them and controlling their movement operate them. So a scooter or riding lawn mower could be no different from a snowplow or street sweeper. The mower is just a *motorized lawn-cutting tool*, the snowplow a *motorized snow shovel*, and the street sweeper a *motorized vacuum cleaner*.

A case could be made for separating riding mowers and scooters according to their engine size. For instance, the State of Alabama considers riding mowers of 15 horsepower and below as *lawn equipment* and assesses a state sales tax. Mowers of 16 horsepower and above are considered *farm equipment* and are not assessed state sales tax.

Because of the wide variety of definitions now in use and disagreement about items like scooters and riding mowers, it is apparent that adopting a single, simple definition for vehicles–that is, registered equipment–would be difficult, but not impossible.

Vehicle Classification

Registered Vehicles. Most vehicles are *registered*, managed through OLVIMS, tracked through AFEMS by the Registered Equipment Management System monitor, and maintained by transportation squadrons' vehicle maintenance flights. The WR-ALC Support Equipment and Vehicle Management Directorate is responsible for their worldwide, integrated management. OLVIMS categorizes vehicles in the registered vehicle fleet as general purpose, special purpose, materiel handling, or base maintenance and assigns budget code V. Despite the category titles, these classifications show primarily how maintenance support is provided to the vehicles, rather than how the vehicles support mission objectives.

Nonregistered Vehicles. Most of the nonregistered vehicle fleet is classified in OLVIMS as organizational equipment, assigned budget code X, and identified by a W, X, or P management code. Low-speed vehicles (scooters), riding mowers, *Bobcat* loaders, and similar items are also considered organizational equipment and carry budget code X but are not listed in OLVIMS.

Budget code X nonregistered vehicles are centrally managed by four air logistics centers (ALC) and locally managed by unit equipment custodians via Custodian Authorization/Custody Receipt Listings (CA/CRL). Budget code "E" nonregistered vehicles are locally procured and managed through the unit CA/CRL. All nonregistered vehicles are tracked through AFEMS like every other equipment item on base. By April 2001, the Support Equipment and Vehicle Management Directorate will have undertaken management of all ground support equipment and nonairborne vehicles, including nonregistered vehicular support equipment. However, some vehicles, assigned to special projects through the Air Force Materiel Command (AFMC) Special Projects Office, are coded “P” and not listed in any accountable system.

In most cases, vehicle maintenance flights maintain the chassis, engine, and transmission (typically the *truck* parts and not the attachments) of the budget code “X” nonregistered vehicles and document the work in OLVIMS. Maintenance for budget code “E” nonregistered vehicles is normally covered under maintenance warranty agreements purchased with the items. This can lead to a proliferation of paperwork and agreements, as demonstrated by a base that had 17 units with scooters assigned. Each of the 17 units had a separate maintenance agreement. If scooters were centrally managed and maintained, economies of scale could be realized not only in item management but also in contract management.

Several other classifications are also used: military or commercial design and war reserve materiel (WRM). These terms are sometimes used in conjunction with, or instead of, the previously mentioned terms and add to the confusion over what a vehicle is and how to classify it.

Fragmented management of items through the various ALCs appears to have developed as a result of the transportation vehicle replacement system’s nonresponsiveness to users’ needs. It has been easier to label a vehicle *equipment* and purchase it through an associated weapon system project office than fight the transportation system for management and funding.

In summary, the lack of a standard classification system for registered and nonregistered vehicles makes it difficult to ensure consistent management practices and prioritize and defend requirements.

War Reserve Materiel. The Air Force WRM program links resource positioning with theater air campaigns via the component USAF War Mobilization Plan (WMP), Volume 4/Wartime Aircraft Activity Report. Guidance and procedures are established for managers to attain and sustain WRM levels to support national strategy reflected in the Defense Planning Guidance and the WMP. AFM 23-110, Volume 2, Part 2, Attachment 3A-1, defines WRM as “materiel required to supplement peacetime assets to completely support the forces, missions, and activities reflected in USAF war plans.” Typically, peacetime assets are regarded as daily use support equipment. However, AFM 23-110, Volume 1, Part 1, Chapter 1, Attachment 1A-1, defines support equipment as:

> . . . all items and quantities of organizational equipment required for support of units not programmed for deployment by the war plans, and those items and quantities that are required in addition to mobility equipment by combat or combat support type units that have a programmed movement in the event of an emergency or wartime situation.

AFM 23-110, Volume III, Part 4, Attachment 5, establishes use codes to identify or support vehicle *authorizations*:

- A mobility authorizations
- B daily-use support authorizations
- C joint-use authorizations
- D pure WRM authorizations

In addition, v*ehicle use codes* are established to identify the actual vehicle *assets* (registered vehicles are the only equipment items in AFEMS that carry separate authorization and asset equipment use codes):

- J mobility assets
- K daily-use support assets
- L joint-use assets
- M pure WRM assets

On 8 March 2000, AFEMS showed:

- 10.1 percent of the registered vehicle fleet is use code A for mobility support.
- 74.0 percent of the registered vehicle fleet is use code B for daily-use support.
- 0.9 percent of the registered vehicle fleet is use code C for joint-use WRM.
- 15.0 percent of the registered vehicle fleet is use code D for WRM.

The high percentage of vehicles listed as *daily use* was alarming at first, with 74 percent of the fleet apparently without a wartime mission and 62 percent identified as mission essential on the base mission-essential levels lists. However, review of Air Force instructions (AFI) made it clear that the problem lies in the definition of *joint use*. Three different definitions for joint use were found:

- AFI 25-101, *War Reserve Materiel Guidance and Procedures Program*–authorized to support a peacetime function that ceases to exist in wartime, allowing the equipment to satisfy a wartime requirement.
- AFI 23-110, Volume 1, Part 2, Chapter 26–items required by existing organizations, which can also be shared with another organization for emergency or wartime missions.
- AFI 23-110, Volume 1, Part 2, Chapter 26, Attachment 26-A-1–authorized to support a base’s peacetime mission but can also be available to support the wartime requirement. Equipment coded for joint use (according to Volume 4, Part 1) will not be classified as WRM. Conversely, WRM equipment will not be classified as joint use.

While joint-use equipment can satisfy WRM requirements, these definitions do not allow for joint use where the wartime and peacetime users are the same organization. The first definition identifies a function “that ceases to exist” in wartime; vehicles assigned to flight-line maintenance could not be joint use since aircraft maintenance continues during wartime. The second definition describes moving an item from one unit to another. The third precludes joint-use items from being classified as

WRM, thereby disallowing a dual wartime/ peacetime label.

The high percentage of vehicles coded for daily use contradicts both the mission essential lists (MEL) lists and everyday experience. Vehicle managers at all levels indicated their primary reason for not using the joint-use WRM code was the difficulties associated with the WRM system. They were concerned that incorrect joint-use codes could lead to unnecessary WRM vehicle purchases when other vehicles could be classified as joint-use WRM. With approximately 37 percent of the vehicles in the Air Force inventory listed by their owning and using units as nonmission essential, there is great potential to reduce the number of *pure* WRM assets by identifying nonmission-essential vehicles as joint-use WRM, thereby filling both peacetime and wartime requirements. An underlying focus of plans and accountable systems is identification of wartime requirements and the availability of suitable assets to meet those requirements. Maybe WRM should be war *requirements* materiel versus war reserve materiel to help focus on *all* wartime requirements, not just reserve materiel.

Vehicle Funding and Procurement

Just as the classification of a vehicle varies depending on its mission, funding methods also vary for registered and nonregistered vehicles. There appear to be dramatic differences in the levels of funding for registered and nonregistered vehicles. This, too, adds to the confusion over the entire vehicle scene.

The Vehicle Priority-Buy Program. The vehicle priority-buy process determines the number and types of registered vehicles eligible for inclusion in the annual Air Force purchase submission. Base-level vehicle managers use the priority-buy module of OLVIMS to develop input to their MAJCOMs. The program allocates funding limits in ten categories, based on the authorized value of the installation vehicle fleet. The process identifies vehicles needing immediate replacement and any projected for replacement over the next 2 years, based on a number of factors including age, mileage, warranty status, and one-time-repair limit. The program does not factor in urgency of need or the vehicles' importance to the mission. After determining the number and types of vehicles *eligible* for inclusion in the base-level submission, fleet managers typically solicit input from unit vehicle control officers and vehicle maintenance flights to help determine what *should be* included. The MAJCOMs combine base-level inputs for submission to the WR-ALC Support Equipment and Vehicle Management Directorate for further compilation to establish the Air Force vehicle-buy budget input to the Combat Support Division in the Air Force Directorate of Supply.

The priority-buy process identifies vehicle requirements in accordance with specific vehicle replacement criteria. However, there is widespread perception in the field that *true* vehicle needs are not being identified because the criteria are questionable. A key criterion missing is mission requirements or the criticality of the vehicle. Vehicles can be prioritized on the submission, as long as they are within the dollar limit for each priority. However, the most critical vehicles often end up in lower priorities because of dollar limitations in the higher priorities. Hence, true requirements are not articulated.

Nonregistered Vehicles. The budgeting and purchase process for nonregistered vehicles is different. Equipment custodians notify their MAJCOM equipment management offices (CEMO) through AFEMS when replacements are needed. The CEMOs work with item managers (IM), who oversee nonregistered vehicles Air Force-wide. The IMs use D200 Requirements Data Bank computations to develop and submit budget requests to the Air Staff through AFMC. After funding is approved, requests are forwarded to the ALCs, where the IMs prepare purchase requests and contracting officers obtain the contracts. IMs direct shipment of vehicles to the units that identified requirements in AFEMS. As with registered vehicles, the process does not include any identification of critical requirements.

Historically, nonregistered vehicles have been fully funded, while the eligible registered fleet has been funded at less than 10 percent. Units are often close to work stoppage if their vehicle requests are not funded, despite the priority-buy process that projects replacements 2 years out. It appears that nonregistered vehicles get more money because they are funded through their associated weapon systems rather than a central vehicle fund. Unfortunately, without accurate fleet data, it is unclear if the nonregistered funding is 100 percent of *requirements* or only of *requests*. With the registered fleet, the 10 percent funding level applies to all vehicles eligible for replacement, not necessarily what is actually needed.

Air Force Space Command Vehicle Initiative. A FY99 congressional funding directive removed funding for general-purpose vehicles (affected most mission-support vehicles Air Force-wide) from the Vehicle Buy Budget Program and replaced only 5-7 percent of replacement needs with lease funding. With 83 percent of vehicles required to support the Minuteman intercontinental ballistic missile suddenly replacement-ineligible, Space Command's Director of Transportation proposed using weapon system funds to purchase them. All vehicles critical to weapon system sustainment (support for alert crews, missile maintenance, security, communications, facility maintenance, and so forth) were identified and prioritized. Minuteman program element 11213 funding was allocated to establish an 11-percent, steady-state purchase plan for vehicle replacements through FY05, and funds were transferred to the WR-ALC Support Equipment and Vehicle Management Directorate to purchase the vehicles. The vehicles carry no restrictions regarding vehicle rotation or assignment, and fleet managers retain control of their fleets.

Should Vehicles Be Reported to OSD?

DoD Directive 5000.nn, *Property, Plant, and Equipment (PP&E) Accountability*, October 1999, establishes policy, standardizes accountability, and assigns responsibility for four categories of PP&E. Weapon systems and the equipment that supports them (excluding vehicles) are reported to the Office of the Secretary of Defense (OSD) under the national defense category. It appears that Air Force vehicles are considered *nontactical* equipment under OSD definitions and should, therefore, not be reported under PP&E guidelines. However, vehicles support preparation:

> . . . for the effective pursuit of war and military operations other than war . . . conduct [of] combat, peacekeeping, and humanitarian military operations; and . . . support [of] civilian authorities during civil emergencies.

And vehicles support the equipment that launches, releases, transports, or fires ordnance and/or transports weapon systems-related property, equipment, materials, or personnel. However, only combat vehicles, "ground or amphibious vehicles (excluding amphibious warfare ships) that are capable of firing ordnance or *carrying military personnel in support of combat operations* (emphasis added)" are reported**.** Mission support PP&E is defined as:

> . . . deployable PP&E that is essential to the effective operation of a weapon system or is used by the DoD or its components to effectively perform their military missions**.** In addition, these items have an indeterminate or unpredictable useful life due to the manner in which they are used, improved, retired, modified, or maintained.

Mission support PP&E should be classified by category of major weapon system (for example, mission support items for aircraft will be reported as *other aircraft support PP&E*). Since the Air Force does not have a standard way to classify vehicles according to the mission they support, it is not possible to report them under the DoD guidelines for PP&E, even though doing so would give decision makers better information about the equipment that supports critical weapon systems. Further, OSD definitions of the various types of vehicles and their missions do not allow consistent classification and reporting.

How could Air Force vehicles be categorized for PP&E reporting? Combat vehicles include those that *carry military personnel in support of the defense mission*. This definition particularly suits the Air Force way of prosecuting combat missions with commercial, off-the-shelf vehicles. Tactical (military design) vehicles are not required for most Air Force missions. However, OSD officials are not in full agreement about which vehicles should be reported. Many believe, for reporting purposes, only *offensive* vehicles (those that can deliver lethal force, with no civilian equivalent) should be considered combat vehicles. A case could be made to list individual vehicle authorizations as national defense or mission support authorizations or as combat vehicles. Further support for this case can be found in DoD 4500.36-R, *Management, Acquisition, and Use of Motor Vehicles*, which states "the USAF uses commercial-design vehicles in tactical roles due to the on-pavement environment of their flight lines."

All the information presented so far indicates there is no standard way to show how essential a particular vehicle is to an individual unit or its mission. Two examples highlight this problem.

First is the situation Space Command faced with its crew vehicles. While they are *general-purpose* vehicles in type and design, they are also critical to the Space Command's mission since they deliver combat missile crews and maintenance teams to front-line weapon systems. However, because there is no data system that reports the criticality of general-purpose vehicles to the nation's warfighting posture, these vehicles have been funded at the same rate as *general-purpose* vehicles with far less critical missions. This has resulted in the rapid deterioration of Space Command's fleet, with no traditional fix in sight.

The second example comes from an Air Force Audit Agency Report of Audit, *Operational Readiness of RED HORSE Squadrons* (Project 97058007, October 1997). The report evaluated Rapid Engineer Deployable Heavy Operational Repair Squadron, Engineer (RED HORSE) operational readiness. RED HORSE provides highly mobile, rapidly deployable operational support to meet force beddown requirements and repair war damage. At the time of the report, seven out of ten RED HORSE units did not have the proper number or types of vehicles required (both general-purpose and specialized construction equipment). Lack of these assets could delay wartime or contingency construction projects. Although these seven units reported vehicle shortfalls of certain vehicle types, eight units maintained other excess vehicles (valued at $3.1M), different from the shortfalls, which could be redistributed to other RED HORSE units that were short.

Identifying Critical Vehicles

Supply and transportation management systems include several systems that could be modified easily for identification, tracking, and reporting of mission critical vehicles.

Mission-Critical Vehicle List. At first glance, Table 7.1 in AFM 24-307, *Procedures for Vehicle Maintenance Management*, appears to be useful in designating registered and nonregistered vehicles as Priority I (sortie generating) and Priority II (sortie sustaining) to help determine priorities for maintenance work. However, maintenance flights do not use these listings to prioritize work; they use MEL lists. So this prioritization seems to be redundant to the MEL lists. In addition, vehicles for critical areas such as aircraft launch are listed simply as various general-purpose vehicles for crew transport and aircraft maintenance. For security forces, only the highly mobile multi-wheeled vehicle (HMMWV) and armored personnel carriers are listed as Priority I, while more than 85 percent of their vehicles are various general-purpose vehicles. Sortie generating is not so much dependent on the type of vehicle (for example, all step vans are not sortie generating), rather on the mission individual vehicles are given.

MEL List. Required by AFI 24-301, *Vehicle Operations*, Chapter 1, the MEL list is the only document that shows vehicle requirements by unit, type, and quantity. There is no standard format or guidance for development or use of the MEL, but samples from 47 bases showed similarities in the basic process. The logistics group commander (LG) approves a vehicle-priority recall list and a maintenance minimum essential list. Units are usually asked for input. The fleet management section compiles the unit-level requests into one list and routes it through vehicle maintenance to the LG. The LG-approved MEL is used by the vehicle operations and vehicle maintenance flight commanders to make vehicle repair and replacement decisions and recall vehicles in support of special peacetime, exercise, or contingency requirements. Although the process appears to be similar across bases, results can differ widely and depend not only on unit missions and needs but also on what individual respondents deem mission essential. MEL lists are only used at base level, and information from them is not reported to higher headquarters.

The *priority recall* field in the Automated Fleet Information System/MAJCOM Automated Fleet Information System programs and modernized OLVIMS could be relabeled to identify MEL vehicle authorizations. Initially, this would give visibility of MEL vehicles to vehicle managers at all levels. In the long run, the field could be converted to a two- or three-position block for a mission item essentiality code (MIEC)-like priority, thereby giving vehicle managers the truest possible picture of vehicle criticality.

In addition to standardizing how MEL-listed vehicles are determined and coded, the MEL list could be reflected in the War Plans Additive Requirements Report (WPARR). Should the MEL numbers be commensurate with WRM use code numbers? If the MEL shows which vehicles are critical to a particular mission and the WPARR is where all wartime requirements should be listed, then should the two lists match closely? Historically, MEL lists only show peacetime vehicle requirements. However, since the Air Force does not have a system to report *all* in-place vehicle requirements, the MEL list could be used.

MIEC. The MIEC is a three-digit code used to show how essential an item is to the wartime mission of a specific weapon system. The first position of the MIEC is the system essentiality code (SEC), showing allocation of resources during wartime, by weapon system importance, at NSN level. The seven SECs are:

SEC/Definition

1 Highly critical system (force activity designator [FAD] I)
2 Strategic system
3 Forward-deployed tactical system
4 CONUS systems in place by D +1
5 Reserve systems in place by D +30
6 Systems in place by D +90
7 Foreign military sales-peculiar applications

The MIEC's second position is the subsystem or equipment essentiality code (SUBSEC) for aircraft and missile components, communications electronic equipment, and support equipment. The four SUBSECs are:

SUBSEC/Description/Definition

A Not mission capable: lack of subsystem prevents the system from doing any wartime or peacetime mission.
B Not wartime capable: lack of subsystem impairs the performance of wartime and assigned missions.
C Not fully capable: lack of subsystem impairs the performance of wartime and assigned missions, but the system can perform its peacetime/training missions.
D Not peacetime or training capable: lack of subsystem prevents the system from performing its peacetime/training missions.

The MIEC's third position is the item essentiality code (IEC), the item's importance to the subsystem. The four IECs are:

IEC/Definition

E Critical for operation
F Impairs operation
G Not critical for operation
M For FMS and can only be used with SEC 7 and SUBSEC D

MIECs are used to calculate requirements in the Recoverable Consumption Item Requirements System (the D041 system). This supply system computes buy and repair requirements for all recoverable items, based on the requisition rate of parts. While the D041 system works well for identifying parts requirements, it is not very effective in determining requirements for *equipment* items, which are normally repaired many times before they are replaced. If the D041 system could be made to identify equipment requirements accurately, a similar model could also identify vehicle needs. The MIEC tables and definitions could be used as a model for MEL lists Air Force-wide. For example, a three-position code could identify:

- Mission type (1-war, 2-direct war support, 3-support, 4-other)
- Mission criticality (A-high, B-medium, C-low)
- Criticality of vehicle to the mission (A- mission critical, B-mission severely degraded, C-mission somewhat degraded, D-no mission degradation)

A table to rank code combinations, like the MIEC ranking table, could be developed to define relative mission essentiality. The sequence might start with 1AA, 2AA, 1AB, 2AB, 1BA, 2BA, 1BB, 2BB, and so on. A code would be assigned to vehicle authorizations and, thus, to assigned vehicles. The codes could be used in the MEL report, which should be standardized and forwarded to MAJCOMs and the Air Staff for determining fleet requirements and capabilities. The codes could also be used in the vehicle priority-buy process to identify criticality of vehicles (by authorization) that need replacing. The priority-buy request could be sequenced by vehicle criticality and would identify true mission needs. This, of course, would require some changes in the priority-buy process and the data systems that support it.

Candidates for Mission Essentiality Codes. Code sets within existing data systems provide information that could be used as is or in conjunction with other codes to display the mission essentiality of each vehicle authorization. The key point here is that the essentiality of a vehicle is defined by its mission, not by the vehicle itself. A vehicle is not critical because it is a certain type (for example, HMMWV versus compact sedan) but because of the mission to which it is assigned.

Some consider it too difficult to assign and track different priorities for vehicles within the same management code or national stock number. This view misses the point that the mission should determine essentiality.

Chapter 15 of AFI 24-301 discusses guidance for authorizing command and control vehicles (predominantly sedans, often leased).

> . . . Air Force commanders with overall responsibility for operations or installation security, and who have a 24-hour emergency response and continuous communications requirement, are authorized command and control vehicles. Authorizations for these vehicles are strictly limited to key command positions, especially in light of statutory restrictions on the use of government vehicles for "domicile-to-duty" transportation . . . .

When a commander has overall responsibility for operations or installation security, the vehicle required to perform that function is mission essential. The command and control authority is given to the position, not to the vehicle, so any vehicle the commander drives carries the command and control designation, thus emphasizing the point that it is the mission being performed that determines essentiality.

There are codes in use by the Air Force supply and finance systems that could be adapted to report criticality or essentiality of vehicles to the mission. These are described below.

Program Element Code (PEC). DoD and Air Force accounting systems use PECs to organize financial resources. Each program has a unique, five-digit PEC. Funding is further broken out by appropriation, budget activity, element of expense, and so on under each PEC. The numbering sequence is logical, based on the type of program. PECs are also used for ordering equipment items. However, only a few PECs are applicable to the purchase of registered vehicles through the priority-buy process. It is noteworthy that only a small percentage of new weapon systems include vehicles in initial planning and programming. Once the new weapon system is online and active, supporting vehicles are purchased under PEC 72831F, along with all other vehicle replacements. The complete list of PECs is available on the AFMC web site and is referred to in AFMC Manual 23-1, *Recoverable Consumption Item Requirement System,* D041. The few mission codes under which vehicles can be included are:

PEC	Title
11213F	Minuteman Squadrons
27588F	Airbase Ground Defense
27597F	Combat Air Forces Training
28028F	Contingency Operations
35145F	Arms Control Implementation
35208F	Distributed Common Ground Systems
41214F	Air Cargo Materiel Handling (463L)
72831F	Replacement Vehicle Equipment
78011F	Industrial Preparedness
91223F	Civil Air Patrol Corporation

A way to identify vehicle funding against a particular program or system would be to assign the unit's PEC against the allowance source code (ASC) within AFEMS. The PEC could be used as part of the definition of the individual ASC. With more than 1,000 PECs in use in the Air Force, a very detailed accounting of which system the vehicles are assigned against could be achieved to help ensure all costs associated with a given weapon system are reported.

FAD Codes. FAD codes are applied to units, organizations, and installations and are used with unit-level equipment purchases (they are not used for central procurement of registered vehicles). Every Air Force unit has an assigned FAD priority. In other words, the mission priority of every unit has already been determined. Thus, the equipment assigned to each unit (including vehicles) could also carry the unit's assigned FAD code, thereby identifying the unit's vehicle priorities. However, this approach would give the same priority to all vehicles assigned to a unit, regardless of the individual vehicles' importance to the mission. For example, a vehicle assigned to a security forces squadron's administration and reports section is not critical to the daily safety and security of a base or weapon system, and its true priority should not be the same as that for a vehicle used to secure alert facilities or munitions storage areas. FAD code categories are listed in Table 1.

Conclusions and Recommendations

1. There is a need for a standard definition of *vehicle.*

Recommendation. Adopt a standard definition for registered equipment (vehicles):

> An equipment item, accounted for in AFEMS, in FSG 17, 23, 24, 38, or 39 or FSC 4210 (or any in an FSG with a material management code "YW"), which operates on the ground, either self-propelled or pulled by a powered item, which performs a specific function or mission, while transporting personnel or cargo.

The following guidelines could be used to help differentiate registered equipment (transportation's responsibility) from nonregistered equipment (supply's responsibility):

FAD I	Reserved for those units, projects, or forces that are most important militarily in the opinion of the Joint Chiefs of Staff (JCS) and as approved by the Secretary of Defense.
FAD II	US combat, combat-ready, and direct combat support forces deployed outside the continental United States (CONUS) in specific theaters or areas designated by the Secretary of Defense on the recommendation of the JCS.
FAD III	All other US combat-ready and direct combat-support forces outside CONUS not included under FAD II.
FAD IV	US forces maintained in a state of combat readiness for deployment to combat during the period D+30 to D+90 (as defined in Joint Dictionary, JCS PUB 1).
FAD V	All other US forces or activities including administrative staff and base post type units.

Table 1. FAD Code Categories

- Is the item generally considered a *vehicle*?
- Is the item in FSG 17, 23, 24, 38, 39, or FSC 4210 (or any in an FSG with a materiel management code "YW")? If the item is not listed, would it fall under one of the classifications if it were?
- Is the equipment item *required* to fulfill an operational mission?
- Does the item require life-cycle management support with technical orders and service bulletin updates?
- Would the Air Force benefit from having this item centrally procured, managed, and maintained?

The standard term *registered equipment* should be used in place of the numerous terms (vehicles, registered vehicles, nonregistered vehicles, organizational equipment, and so forth) now used in transportation, supply, and war-planning instructions and manuals.

A standard definition for registered equipment, at this time, would apply only to equipment management authority and actions such as assigning mission priority. The procurement and maintenance of the various registered and nonregistered equipment items would remain as currently assigned, unless changes are deemed appropriate through another study or special team recommendation.

2. Air Force registered equipment (vehicles) is not being centrally managed as described by AFM 23-110. Although most vehicles are centrally managed by WR-ALC, many are not. Guidelines allow program managers to decide whether to call an item a *vehicle* or *equipment*, thereby determining where the item is managed.

Recommendation. Centrally manage all registered equipment (as defined above) through WR-ALC Support Equipment and Vehicle Management Directorate as outlined in AFM 23-110.

3. Likewise, classification for mission-essential vehicles should be defined and made the focus of the Air Force vehicle priority-buy process. New vehicle classification systems are not required to improve vehicle management. The Air Force has several current systems that can adequately tie vehicles to their associated missions. Mission-essentiality codes would not necessarily replace existing data elements or systems but would use or supplement them to identify the criticality of vehicle requirements. Such a system would identify not only vehicle needs for contingency and force planning purposes, such as the EAF, but also mission-based requirements for the Air Force vehicle fleet.

Recommendations.

a. Standardize the definitions of supply equipment use codes Air Force-wide.

Use Code/Definition

A Mobility: items planned to be taken with a unit when deploying.

B Daily use: items used to maintain the weapon in a ready state and to launch/deploy (peacetime and wartime user is the same).

C Joint use: items used on a daily basis but transferred to another unit during contingency/mobilization (peacetime and wartime users different).

D Pure WRM: items that must be available and waiting at the forward location.

E Peacetime use (new code added): items available on a daily basis but not needed during contingency/wartime/mobilization and not dedicated to another unit.

b. Adopt a standard method for determining vehicle mission-essential levels using a system like the MIEC list as the basis.

c. Rename the *priority recall* field in the fleet management module of modernized OLVIMS to identify MEL authorizations. Initially, this will give transportation managers at all levels visibility over MEL vehicles. In the long run, the field could be converted to a two- or three-position MIEC-like priority code, thus giving transportation managers the truest possible picture of equipment criticality.

d. Program element codes should be added to the definitions of every vehicle authorization, under the allowance source code, to identify the exact program element each vehicle is authorized to support. Eventually, PECs should be added to OLVIMS as an independent field for sorting vehicles.

e. Apply FAD codes of each unit to the registered equipment authorizations for that unit, within AFEMS, as opposed to the generic FAD code for base transportation or no FAD code at all.

f. Explore the feasibility of having individual program elements budget for and fund replacements for their registered equipment.

4. Air Force vehicles are not reported to the OSD and Congress with their associated weapon system, as described in DoD 5000.nn, *Property, Plant and Equipment Accountability*.

Recommendation. Transportation leaders urge the Air Force corporate staff to address the issue of proper reporting of registered equipment according to DoD 5000.nn through the OSD and Congress.

Notes

1. AF/XPOE Fact Sheet, EAF Implementation.

AFLMA Analysis

Captain Todd A. Dyer

Leasing Wide-Body Aircraft

During pre-CRAF emergencies, the DoD sometimes experiences difficulties acquiring the additional airlift required for passenger movements.

Headquarters United States Transportation Command (USTRANSCOM) and Headquarters Air Mobility Command (AMC) use commercial air carriers that participate in the Civil Reserve Air Fleet (CRAF) to transport passengers during peacetime, wartime, and contingencies. CRAF provides approximately one-third of USTRANSCOM's airlift capability and most of the Department of Defense's (DoD) passenger airlift capability. Specifically, the US charter airline industry provides a significant number of passenger aircraft to the CRAF. This was demonstrated during Operations Desert Shield/Storm, when commercial carriers moved 64 percent of the passengers during deployment and 84 percent during redeployment. During peacetime, CRAF-participating carriers transport military members and their families to and from overseas locations on scheduled missions via the Patriot Express program, using annual contracts. Additional missions are negotiated and paid under separate contracts.

The United States must be able to deploy large numbers of its forces rapidly for unexpected emergencies, but these types of contingencies do not require CRAF activation and are called pre-CRAF emergencies. In these situations, DoD deploys forces in response to contingencies that develop with little or no warning, with support from US commercial air carriers, to provide the required, additional airlift. USTRANSCOM estimates 15 wide-body aircraft equivalents are needed, on average, to meet pre-CRAF emergency passenger-movement requirements.

During pre-CRAF emergencies, DoD sometimes experiences difficulties acquiring the additional airlift required for passenger movements. USTRANSCOM is investigating the possibility of improving customer satisfaction and reducing costs by entering into long-term wet leases with nonscheduled (charter) carriers. The hypothesis is that both parties could benefit, with guaranteed business for the carriers and guaranteed aircraft availability and cost savings for DoD. USTRANSCOM requested the assistance of the Air Force Logistics Management Agency (AFLMA) to assess the feasibility of leasing wide-body-equivalent passenger aircraft from charter air carriers. The focus of the study was to be a cost-benefit analysis of the tradeoff between the savings achieved from a lower hourly rate versus the cost of paying for idle hours (excess capacity). Excess capacity is gained when all an aircraft's scheduled flying hours are exhausted and extra hours are still available for use. It is a valuable commodity that could provide the security of dedicated aircraft to supplement pre-CRAF requirements. Lease options, as a minimum, would include:

- Aircraft, maintenance, insurance, and crew
- Employee per diem at government rates
- Aircraft and air traffic servicing
- Passenger service
- Fuel, oil, and aircraft supplies
- Maintenance and depreciation of general ground property
- General and administrative profit

The study was intended to aid USTRANSCOM in determining the feasibility of entering into long-term leases with commercial air carriers. However, the results of the study were limited by the small amount of financial data provided by the commercial carriers. No in-depth analysis was possible to determine the costs associated with leasing aircraft versus yearly contracts based on predetermined routes. Also, AFLMA cannot determine the value of excess capacity. That determination needs to be made by USTRANSCOM and AMC.

Discussion and Analysis

A critical step in this study was defining wet lease and full-service lease. Under a wet lease, the air carrier provides only the aircraft, cockpit crew, maintenance, and insurance. A *full-service lease* includes all the goods and services of a wet lease plus cabin crews, ground and in-flight support, and fuel.

Understanding the Patriot Express program, which moves military members and their families to and from overseas locations, was also important. The program uses fixed and expansion missions. Fixed missions are established, recurring missions, such as Baltimore-Washington International Airport to Frankfurt International Airport, Germany. Expansion missions are outside the fixed schedule and support exercises, contingencies, and special assignment airlift missions. Occasionally, some fixed missions may be contracted as expansion missions, if a requirement comes in after the fixed-mission contract was awarded. In FY00, the Patriot Express fixed-mission contract cost was approximately $148.1M and the expanded-mission contract cost about $167.7M.

The preliminary analysis also included reviewing two studies. The first was conducted by the Logistics Management Institute (LMI) in May 1999, *Improving Charter Passenger Airlift Business Practices*. LMI was commissioned by the USTRANSCOM Business Center to study the Patriot Express airlift program to determine if the charter aircraft industry could meet pre-CRAF requirements. They also evaluated USTRANSCOM's peacetime business rules for potential efficiencies: how should USTRANSCOM modify its peacetime business rules to increase pre-CRAF passenger aircraft availability and use its commercial passenger investments more efficiently? LMI found that AMC could negotiate long-term, full-service leases for wide-body passenger aircraft and integrate them into daily operations. They would also need to develop a strategy for using the excess airlift capability created by the leases designed to support pre-CRAF requirements. Leasing was expected to reduce the cost per flying hour by 20 to 30 percent if AMC guaranteed a minimum number of daily flying hours. AMC would have to pay for the promised daily use, so cost savings could not be realized if they were not able to fly enough hours to meet the break-even point. The LMI study also found that some benefits could be gained through alternative methods of acquiring commercial passenger charter aircraft: increased wartime readiness and customer satisfaction, along with others.

The AMC Contract Airlift Division accomplished a limited cost analysis that showed leasing may be cost prohibitive. It was a simple comparison of AMC's international charter contract price and lease costs using three air carriers: World Airways, Tower Air, and American Trans Air. Each airline provided estimated costs for a portion of the total estimated lease costs. The other cost estimates shown below were based on historical data or current industry standards. Eight individual costs comprised the calculation:

- Aircraft, maintenance, insurance, and crew
- Employee per diem (government rate)

- Aircraft and traffic servicing
- Passenger service
- Fuel, oil, and aircraft supplies
- General ground property
- General and administrative costs and profit
- Cost of service during aircraft A&C checks (not included in World Airlines cost estimate)

The cost estimates factored in the types of aircraft and routes (Atlantic or Pacific). The World Airways estimate was based on a DC-10 flying the Atlantic routes and an MD-11 flying the Pacific routes. Tower Air's estimate used a B-747 on the Pacific route, and American Trans Air's estimate used an L1011 on the Pacific route. The AMC Contract Airlift Division found the lease costs were between 2 and 30 percent higher. For example, Tower Air's estimated lease cost only increased 2 percent, from $50.8M per year under the international charter contract to $51.9M per year under a lease contract. American Trans Air's lease costs were nearly 30 percent higher than the international charter contract costs, $39.9M per year compared to $51.8M per year. Therefore, the AMC Contract Airlift Division recommended not using these cost-prohibitive, long-term, full-service leases.

However, after reviewing both studies, the commander in chief, USTRANSCOM asked that AFLMA conduct a more in-depth study of the feasibility of leasing wide-body passenger aircraft.

The team first developed a list of potential aircraft fleet sizes and mission schedules using information generated by a mathematical optimization of historical data from the AMC CRAF Division. USTRANSCOM specified that the analysis include only Patriot Express fixed-mission contracts for Atlantic and Pacific routes using MD-11, DC-10, and L1011 aircraft. It also asked AFLMA to identify excess capacity generated by leasing. Then, the team sent out a request for information to learn if air carriers were interested in leasing their aircraft and if enough airframes would be available to match the desired fleet size.

Request for Information

The request was issued in three parts: a statement of work (SOW), contract terms, and optimized mission schedules. The SOW specified services that DoD and the air carriers would provide. For example, DoD would provide aircraft towing, parking, and passenger processing at military installations, at no cost to the contractor. The carrier would provide these services at commercial airports. The air carrier would also provide services such as in-flight meals and snacks. Three alternative contract terms were offered, all for combinations of base and option years totaling 5 years. These are standard lease periods that charter airlines commonly use. Air carriers were asked to place an offer on each option. The lease periods were:

- 1 base year, 4 option years
- 2 base years, 3 option years
- 3 base years, 2 option years

Seven proposed mission schedules were listed in the request as individual contract line item numbers (CLIN), each with a specified number of seats required. Carriers were asked to place separate offers on each CLIN.

The entire request was posted on the Federal Electronic Posting System Internet site (www.eps.gov) on 3 August 2000. This web site provides commercial industries with information about potential business opportunities with the US Government. Carriers were given until 11 August 2000 to submit an offer.

No offers were received by the deadline so it was extended to 29 August 2000. By 5 September 2000, still no offers had been received. So the team contacted air carriers by telephone or e-mail to determine why they had not submitted offers. Only two carriers demonstrated any interest in submitting an offer, and by 16 October 2000, only one had done so–American Trans Air.

The team made several attempts to contact other carriers for offers, but to no avail. The carriers may have decided not to respond to the request for any number of reasons. First, there was no financial incentive to do so since the request was for information, not business. They may have opted to invest resources in pursuing actions that would result in contracts rather than provide cost data for a research effort. Second, the Patriot Express expanded-mission program provides significant business opportunities for air carriers. In FY00, the Patriot Express expanded-mission program totaled some $167.7M. Leasing wide-body passenger aircraft could eliminate the expanded-mission program, thus eliminating a major profit-making business for carriers. Finally, under current law, no more than 40 percent of carrier annual revenue can come from DoD for carrier participating in CRAF. Leasing aircraft might push air carriers over the 40 percent mark. Discussion with USTRANSCOM staff members revealed this rule might not be realistic in a leasing environment and should be reevaluated if leasing were to be initiated.

Optimized Schedules

The next step was obtaining the Patriot Express fixed-mission passenger schedules (Atlantic and Pacific) for the year 2000. A linear program was developed that presented a number of aircraft fleet-size options to aid USTRANSCOM in determining the fleet size required. Optimal fleet size and mission routing were determined using two criteria: maximizing use of aircraft and minimizing aircraft repositioning. The linear program sought solutions that performed well in both areas. Several factors were included in the analysis:

- One aircraft per mission.
- Aircraft cannot complete overlapping missions.
- Reposition aircraft only if a mission's terminating point is not the same as the next mission's starting point.

Later, it became evident that repositioning aircraft was not a decisive factor in the equation, so the linear program was refined to provide mission schedulers a range of mission planning options. The program provided a tradeoff between maximum or balanced usage. Under the maximum-usage option, no constraints were placed on aircraft use. One aircraft could fly an aggressive schedule and another fly only sparingly, resulting in unbalanced usage of the two aircraft. Under the balanced-usage option, each aircraft was used approximately equally.

The results of the linear program were depicted in five categories: utilization, block hours, idle time, relocation time, and costs.

- Usage was the time an aircraft is considered in use, including block hours, ground time, and relocation time. The usage formula is:

Block hours + relocation time +
ground time = usage

- Block hours started when a plane pulled away from a gate and ended when it pulled back into a gate.
- Ground time was the time planned for servicing an aircraft before its next mission. A standard ground time of 1 hour and 30 minutes was used for all Patriot Express missions.
- Idle time was the time an aircraft was not in use. It could be used for maintenance or excess capacity.
- Relocation time was the time required to move an aircraft from an ending point to a new starting point.

The cost of operating each aircraft in the various usage scenarios was also included for each route. These costs were based on current charter rates under AMC's FY00 international contract. In the report, these figures were referred to as *the current charter costs to operate an aircraft* (MD-11, DC-10, and L1011) and provided as a basis of comparison for the cost-benefit analysis.

Optimized Schedule Results—Pacific Region

Analysis of the Pacific region was less complicated than that for the Atlantic region because it involved only one aircraft type and two departure and arrival locations. The MD-11 was selected for this region because it was the only aircraft of the three that met passenger capacity requirements based on historical demand data. Analysis of a single-aircraft option, shown in Table 1, provides an MD-11 with daily averages of 10.86 block hours and 6.3 idle hours. However, this scenario's aggressive flying schedule may not allow time for scheduled maintenance.

A two-aircraft, balanced-use option was less taxing (Table 2). Two MD-11s could be used an average of 5.42 and 5.44 block hours daily. Their daily idle time averaged 14.77 and 14.71 hours, respectively, which could be used for excess capacity or scheduled maintenance. The total annual cost to operate these two aircraft in the Pacific region was roughly $51.3M.

(Average Hours/Day)	
Utilization	17.70
Block hours	10.86
Idle time	6.30
Relocation time	.54
Cost (per year)	$51,322,532.40

Table 1. Pacific Region Maximum Usage

MD-11 #1 (Average Hours/Day)	
Utilization	9.23
Block hours	5.42
Idle time	14.77
Relocation time	.46
Cost per year	$25,641,475.20
MD-11 #2 (Average Hours/Day)	
Utilization	9.29
Block hours	5.44
Idle time	14.71
Relocation time	.46
Cost per year	$25,681,057.20

Table 2. Pacific Region Balanced Usage

Optimized Schedule Results—Atlantic Region

Atlantic region calculations were more complicated because of the number of aircraft combinations available and the increased number of departure and arrival locations. The Atlantic region solution tried a variety of aircraft combinations:

- One aircraft (MD-11, DC-10, or L1011)
- Two aircraft (two MD-11s, MD-11 and DC-10, MD-11 and L1011)
- Three aircraft (three MD-11s; two MD-11s and DC-10; two MD-11s and L1011; MD-11, DC-10, and L1011)

Results of the two- and three-aircraft scenarios are described below and samples summarized in Tables 3 and 4.

Table 3 depicts a sample of the two-aircraft scenarios. In the balanced-use option, a DC-10 and MD-11 were used an average of 7.68 and 7.67 block hours daily, respectively. Their idle time averaged 13.56 and 13.40 hours and could be used for maintenance or as excess capacity. Only 447.83 block hours were available, which equated to 20 required missions left unfilled, at an annual cost of $4.8M for additional aircraft. The number of unfilled missions showed that two aircraft were not enough to meet mission requirements in the Atlantic region. The current annual charter cost to operate an MD-11 on this schedule was about $35M, and a DC-10's annual cost was about $30.3M. The total current annual charter cost to operate these aircraft at maximum usage, not including the 20 unfilled Patriot Express missions, was about $65M

In the two-aircraft maximum-usage option, the MD-11 and DC-10 would be used an average of 8.81 and 6.56 block hours daily, respectively. The MD-11 had about 12 hours of idle time, while the DC-10 would have about 15 hours. With just these two aircraft, 428.42 hours (19 Patriot Express missions) could not be filled, at an annual cost of $4.6M for additional charter aircraft. And the number of unfilled missions again showed that two aircraft were not enough to meet mission requirements in the Atlantic region. The current annual charter cost for an MD-11 in the maximum-usage scenario increased slightly to $39.2M, compared to the balanced-usage scenario. The current annual charter cost for the DC-10 dropped slightly to $26.5M. The current annual charter cost for these aircraft at maximum-usage, not including the 19 unfilled Patriot Express missions, is about $65M.

Table 4 depicts a sample of the three-aircraft scenario. In the balanced-usage scenario, the aircraft had about the same average number of block hours daily: 5.52 for the MD-11, 5.46 for the DC-10, and 5.50 for the L1011. Idle time for all three aircraft totaled 48.89 hours. Unlike the results of the two-aircraft option, all missions and block hours were filled. Therefore, three aircraft were the minimum number needed to meet the Patriot Express fixed-mission schedule. The current annual charter cost for balanced use of these three aircraft was about $69.6M.

In the maximum-use option, the MD-11 was used more often than the other two aircraft. It had 8.77 average daily block hours, compared to the DC-10's 5.14 and the L1011's 2.69. Because of the MD-11's heavier use, the DC-10 and L1011 had 35.81 idle hours. Again, using three aircraft allowed all missions and blocks hours to be filled. Three aircraft were the minimum number needed to meet Patriot Express fixed-mission schedule requirements in the Atlantic region. The current annual charter cost for the maximum-use scenario matches that of the balanced-use scenario at nearly $69.6M.

Optimization of the Atlantic and Pacific schedules provided a tradeoff between two possible options. One option used more aircraft at a higher cost to complete more scheduled missions (more excess capacity). The other option used fewer aircraft at a lower cost but completed fewer scheduled missions and had less or no excess capacity.

Estimated Lease Cost Data

Only American Trans Air submitted an offer in response to the request for information. Its estimate

	Average Hours/Day	Balanced	Max Usage
MD-11	Utilization	10.60	12.01
	Block hours	7.67	8.81
	Idle time	13.40	11.99
	Relocation time	.21	.30
	Cost per year	$34,977,442.14	$39,279,469.20
DC-10	Utilization	10.44	9.01
	Block hours	7.68	6.56
	Idle time	13.56	14.99
	Relocation time	.20	.17
	Cost per year	$30,320,448.60	$26,525,667.86
Not Filled	**Total**		
	Block hours	447.83	428.42
	Missions	20	19
	Cost per year	$4,820,874.84	$4,610.582.60

Table 3. Two-aircraft Maximum Usage Scenario

	Average Hours/Day	Balanced	Max Usage
MD-11	Utilization	7.67	11.91
	Block hours	5.52	8.77
	Idle time	16.33	12.09
	Relocation time	.15	0.30
	Cost per year	$26,820.270.54	$39,211,218.52
DC-10	Utilization	7.45	7.22
	Block hours	5.46	5.14
	Idle time	16.55	16.78
	Relocation time	.11	.14
	Cost per year	$22,124,490.66	$20,314,883.84
L-1011	Utilization	7.99	4.07
	Block hours	5.50	2.69
	Idle time	16.01	19.93
	Relocation time	.14	.07
	Cost per year	$20,751,434.60	$10,170,093.44
Not Filled	**Total**		
	Block hours	0	0
	Missions	0	0
	Cost per year	0	0

Table 4. Three-aircraft Scenario

was based on a full-service lease that would provide the aircraft, crew, insurance, maintenance, fuel, catering, and ground services at commercial airports at a fee. The submittal did not separate costs into three lease periods as requested but used the following methodology. Each aircraft was offered on a full-year, guaranteed basis (the price would be higher for a shorter period). The price was based on a set fuel cost of 78 cents per gallon (the price would be higher if the carrier were to assume the full risk of a variable fuel cost). The offer was based on a minimum number of block hours, per aircraft, per month at a specific rate per block hour. If DoD were to exceed the minimum number of block hours per month, they would pay the excess rate. The cost formula is depicted below:

Block-hour rate x number of hours actually flown = total cost

However, if DoD were to fly less than the minimum number of block hours per month, they would still be required to pay the minimum cost. The cost formula is depicted below:

Block-hour rate x minimum blocks per month = total cost

Table 5 shows American Trans Air estimates, by aircraft type, for number of seats, minimum block hours per month, block-hour rate, and minimum cost per month and year.

Its estimate offer covered all CLINs. Examples of offers for the Atlantic and Pacific routes follow. They compare the cost of operating the optimized schedules on the regional route and show where minimal block hours are and are not met.

CLIN 3 covers the missions described in the Atlantic region two-aircraft option. American Trans Air determined it would require 254.40 blocks hours a month, on average, for an MD-11 and 179.69 blocks hours for a DC-10. This was 145.60 and 80.31 block hours, respectively, short of the minimum monthly guarantee, if no other flying were added. According to American Trans Air, DoD would be required to pay the minimum cost per year for a total of $90.3M for all three aircraft on this route.

CLIN 4 covered the Atlantic route described in the three-aircraft option. According to American Trans Air, the average total block hours associated with this schedule were 208.51 for an MD-11, 166.17 for a DC-10, and 164.02 for an L1011. These block hours fell short of the minimum required if no other flying were added. The MD-11 fell short by 191.49 hours, the DC-10 by 93.83 hours, and the L1011 by 110.98 hours. According to Table 5, DoD would be required to pay the minimum cost per year for a total of $129.6M for all three aircraft on this route.

CLINs 6 and 7 covered the Pacific route and required the use of one MD-11 flying an average of 335.54 block hours per month, more than the guaranteed monthly minimum. DoD would have to pay $14,000 per block hour, for a total of approximately $56M annually.

Cost-Benefit Analysis

The premise of this study was that USTRANSCOM and AMC could lease wide-body aircraft at a better hourly rate as long as they guaranteed carriers a minimum number of hours. The downside would be having to pay for those hours whether they were used or not. The initial plan was to conduct a cost-benefit analysis to study the tradeoff between the savings from a lower hourly rate versus the cost of paying for unused hours (excess capacity). Excess capacity is a valuable commodity. If the cost turned out to be greater than the savings, then USTRANSCOM and AMC would pay X amount of additional dollars for Y number of excess capacity hours. In addition, they would have the security of dedicated aircraft to supplement the pre-CRAF requirement.

However, the American Trans Air offer suggested there are no savings to offset the costs of full-service leasing. When charter airlines are not flying for DoD, they must find business elsewhere. Finding additional business from DoD is important to the carriers because they lose money when aircraft sit idle. American Trans Air reported it would lease DoD the same aircraft as chartered if DoD guaranteed 260 block hours per month. When ground and maintenance time is added, there is very little time left for the aircraft to sit idle. DoD would be guaranteeing 100 percent use of the aircraft without the carrier's having to solicit business from other customers and juggle schedules to maximize resource use. The promise of guaranteed business should be worth a lower block-hour rate; in other words, a *bulk rate*.

To provide a basis of further comparison between block-hour costs, the estimated current charter rate costs used in the schedule optimization were converted into block-hour costs by adding the total annual cost associated with a schedule scenario and dividing that number by the total block hours flown annually. For example, the Atlantic region three-aircraft, balanced-use scenario total cost was $69.6M, and the total annual block hours were 6,015.2. The total annual cost divided by the total block hours was approximately $11,570. The cost formula is depicted as follows:

Aircraft Type	Seats	Minimum Block Hours/Month	Block Hour Rate	Minimum Cost/Month	Minimum Cost/Year
MD-11	360	300	$14,000	$4,200,000	$50,400,000
DC-10-30	330	260	$12,800	$3,328,000	$39,936,000
L1011-500	307	275	$11,900	$3,275,000	$39,306,000

Table 5. American Trans Air Lease Estimate

Total costs per year/block hours per year =cost per block hour

The comparison of block-hour rates showed that American Trans Air's rates were slightly higher than the converted charter rates. For example, the Atlantic region three-aircraft, balanced-use scenario's converted charter rate, block-hour cost was about $12,000. American Trans Air's block-hour rate varied between $12,000 and $14,000 depending on the type of aircraft used. The complete results of this comparison are located in Figure 1. The key to the chart is:

Pacific 1 = 1-aircraft, maximum use

Pacific 2 = 2-aircraft, balanced use

Atlantic 2b = 2-aircraft, balanced use

Atlantic 2m = 2-aircraft, maximum use

Atlantic 3b = 3-aircraft, balanced use

Atlantic 3m = 3-aircraft, maximum use

MD-11, DC-10, and L1011 numbers provided by American Trans Air

Under the FY00 AMC international charter contract, American Trans Air charged DoD $10,732.32 per block hour for DC-10 charter missions. However, under the terms of a full-service lease, it would charge $11,900.00, $1.167.68 more per block hour.

Under American Trans Air's lease estimate, DoD would not receive any financial benefit (lower block-hour rate), which is contrary to the logic of the study's premise. American Trans Air would charge a higher rate even though DoD would guarantee business for a year. Furthermore, the estimate did not specify that unused block hours would be available to DoD for extra missions. Therefore, given the unfavorable terms of the estimate, further cost-benefit analysis was not considered necessary.

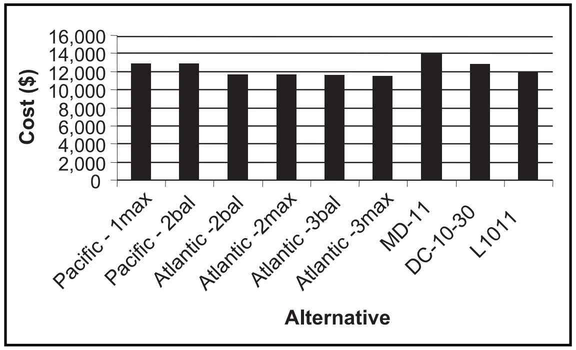


Figure 6. Block-hour Comparison

Other Findings

DoD could lease wide-body aircraft directly from aircraft manufacturers to meet pre-CRAF requirements. These aircraft could be operated and maintained by Air Force personnel. A predetermined number of aircraft could be stationed on the Atlantic and Pacific coasts to meet deployment requirements. This method of leasing aircraft is a possible alternative to meeting both Patriot Express and pre-CRAF requirements. While this subject was outside the scope of this study, it should be investigated further.

If it is decided to continue use of annual contracts for Patriot Express missions, AMC and USTRANSCOM might benefit if they were to use annual contracts with option years. This type of contract provides a longer term relationship with air carriers and allows extension of the contract if the carrier performs well. Plus, long-term contracts could provide air carriers with a guaranteed business stream for several years. This subject should also be further investigated.

Conclusions

Only one air carrier responded to the request for information. There may be several reasons for the carriers' apparent lack of interest in leasing wide-body aircraft to DoD. First, carriers knew the contract within the RFI was not a *real* proposal and they would not realize any financial return from replying to it. Second, if leasing were initiated, air carriers could lose revenue they now get from Patriot Express expansion missions. Finally, law limits the amount of revenue air carriers participating in CRAF can earn from DoD. Leasing aircraft could push them past that mark.

American Trans Air was the only airline to submit a lease cost offer. Its offer was compared to estimated costs from the FY00 AMC international contract. Its offer costs were higher than the estimated AMC international contract prices. For example, operating an MD-11 and a DC-10 in the Atlantic region in a balanced-use scenario, not including unfilled Patriot Express fixed missions, would cost $65M using current annual charter costs. American Trans Air offered to lease the same aircraft for $90.3M. Similarly, operating three aircraft in the Atlantic region (MD-11, DC-10, and L1011) is estimated to cost about $69.6M under the current AMC contract price; American Trans Air estimated it would cost roughly $129.6M to provide the same service.

A cost-per-block-hour comparison also revealed American Trans Air's estimated lease costs to be slightly higher. Specifically, a review of DC-10 costs showed that American Trans Air would charge $1,167 more per block hour than the rate charged under the FY00 AMC international contract. The higher block rate indicates DoD would not receive any financial benefit for guaranteeing a year's worth of business. Additionally, American Trans Air did not state that it would guarantee unused block hours would be available for extra DoD missions.

However, USTRANSCOM and AMC might receive more favorable lease estimates if an actual proposal were offered to air carriers. An actual proposal might provide carriers with sufficient financial motivation to submit their best lease offers.

It is important to note that, although the cost of leasing wide-body aircraft appears to be higher, USTRANSCOM needs to determine the true *value* of leasing as it relates to transportation readiness. This study shows leasing may be a viable option if ensuring aircraft are always available to meet pre-CRAF requirements; the extra cost of leasing aircraft may be worth the gain in aircraft availability.

Recommendations

- USTRANSCOM, in conjunction with AMC, must determine the value of excess capacity received with leasing wide-body aircraft to ensure transportation readiness.
- USTRANSCOM and AMC should continue to investigate the possibilities of leasing wide-body aircraft. They should contact air carriers directly to determine their interest in pursuing this business alternative.
- For future reference and studies, USTRANSCOM and AMC should use the term *full-service lease*, rather than *wet lease*. There is a dramatic difference between the services provided and the costs associated with each one. The services USTRANSCOM and AMC are looking for are best described as a full-service lease.
- USTRANSCOM and AMC should explore the option of directly leasing wide-body aircraft from aircraft manufacturers.
- If leasing is not pursued, USTRANSCOM and AMC should investigate the potential of using annual contracts with option years for the Patriot Express program.

Perhaps the most significant lesson of World War II is that the military potential of a nation is directly proportional to the nation's logistic potential. The first hard fact to be faced in applying that lesson is that our resources are limited. The next is that the slightest delay or inefficiency in harnessing our logistic resources may cost us victory.

—Major General O. R. Cook, USA

Contractors on the Battlefield

If contractors leave their jobs during a crisis or hostile situation, the readiness of vital defense systems and the ability of the Armed Forces to perform their assigned missions would be jeopardized.

—DoD Inspector General, 1991

During the last decade, the only constant in the military landscape has been change. A dominant element within all this change has been increased use of contractors and contractor support. From now and into the foreseeable future, when the US military deploys—whether for crisis response, peacekeeping, nation building, or warfare—contractors will deploy with them.[1] Civilian contractors have accompanied and supported troops in the field throughout much of history. What makes it significant now is the level of support, location, and criticality of the support they now provide.[2] Today, contractors are providing virtually all the logistics support for some new weapon systems, maintaining fielded weapon systems, providing much of the logistics support for entire operations, directly supporting commanders in the field, and operating information and intelligence systems. Never before has tactical success relied so heavily on nonmilitary personnel.[3] Never before has the distinction between civilian and soldier been so blurred.[4] Because of this, the military is facing a fundamental change in the way it conducts and supports warfare.

Contractor Support: A Brief History

The use of civilian contractors for support within the US military is not a new phenomenon. Prior to World War II, support from the private sector was common. It was not until the Cold War that government support became standard.

> Lest you think this is a new phenomenon, let me take you back to the era before World War II when private support was standard. It was only during the Cold War when we realized the huge buildup of government operations that we came to think of government support as the norm.[5]

The philosophy regarding the use of civilians in noncombat roles remained relatively unchanged from the period of time encompassing the Revolutionary War and the War of 1812 through the Vietnam conflict. Their primary role was logistics support; for example, transportation, provisioning, engineering, communications, and medical services.[6] In general, it was believed the use of civilians in support areas would allow soldiers to focus on military or warfighting responsibilities. This made sense because most logistical tasks were specialized functions available from commercial sources.[7]

With the Vietnam conflict, the role of the contractor began to change.[8] They performed some of the same tasks as—and worked side by side with—deployed soldiers. No longer relegated to just basic support tasks, they were, in fact, technical specialists—experts in the tools of war. A major reason for this was the increasing complexity of military equipment and hardware.[9] Since then, the trend has been for an increasing number of contractors to support both logistics and combat operations. During the war in the Gulf, 1 in 50 of those deployed was a civilian contractor. For operations in the Balkans, it was 1 in 10.[10] It is expected that this ratio will shrink even further as more and more activities or functions are outsourced or privatized.

Three factors have been responsible for the increased use of contractors: downsizing of the military following the Gulf War, a growing reliance on contractors to support high-tech weaponry and provide initial or lifetime support for weapon systems and, a push to outsource or privatize functions to improve efficiency and accrue funds for sustainment and modernization programs.[11]

The argument can also be made for a fourth reason—relief from troop ceiling restrictions. Following the end of the Cold War, approximately 1 million people (military and civilian) were eliminated DoD-wide.[12] At the same time, all the Services have seen an increase in operating tempos. This has necessitated increased use of contractor personnel to perform jobs previously held by military personnel. From a DoD-wide perspective, in many cases, these skills are more closely related to operations than the historical logistics or support focus.

The continued and rapid expansion of technology and sophisticated high-tech weaponry has made it uneconomical to keep military personnel capable of maintaining and, in some cases, operating sophisticated equipment.[13] For similar reasons, there has been a move to rely on contractor support during the initial fielding of a weapon system. In the past, DoD policy was to transition from initial contractor support as soon as possible in order to eliminate potential overreliance on civilian technical support. However, today, the policy is completely reversed. Congressional language now requires that contractors maintain and support new critical weapon systems for at least 4 years and for the life of noncritical systems.

Personnel reductions and budget imperatives have been driving factors in the move to outsource or privatize many functions and activities.

Outsourcing and Privatization

Outsourcing and privatization (competitive sourcing and privatization within the Air Force) is the *transfer of a support function traditionally performed by an in-house organization to an outside service provider, with the government continuing to provide appropriate oversight.*[14] The Defense Science Board defines *privatization* as "involving not only the contracting out of support functions, but also the transfer of facilities, equipment, and other government assets to the private vendor."[15]

The intent of outsourcing and privatization within DoD is to lower costs and improve performance while improving readiness, generating savings for modernization, and improving the quality and efficiency of warfighter support.[16] Savings are expected to accrue over time despite the initial short-term costs associated with changing from a military or civilian work force to a contracted work force. In addition to the cost savings, it is expected that the competitive process will allow the military to identify the most efficient way to deliver support services. By identifying alternative and innovative support approaches, military personnel can focus on core missions. Within the Air Force, the number one goal of competitive sourcing and privatization is to sustain readiness. This is followed by improving performance, quality, efficiency, and cost-effectiveness; generating savings for modernization; and focusing personnel and resources on core activities.[17]

The full impact of outsourcing and privatization efforts is still emerging. However, there are some significant points to consider. There have been impediments to outsourcing within the military environment as a whole. The Defense Science Board defined the primary impediment as the "resistance of the DoD culture to fundamental change."[18] Further, the board attributed the military's hostility to privatization to its readiness, rather than efficiency orientation.[19]

Notes

1. Col Steven J. Zamparelli, "Contractors on the Battlefield—What Have We Signed Up For," *Air Force Journal of Logistics*, Vol XXIII, No 3, 9.
2. *Ibid*.
3. *Ibid*.
4. *Ibid*.
5. Sheila E. Widnall, Secretary of the Air Force, "Privatization—A Challenge of the Future," remarks at the Base and Civic Leader Dinner, McClellan AFB, California, 7 Feb 96.
6. Maj William E. Epley, "Contracting in War: Civilian Combat Support of Fielded Armies," Washington DC: US Army Center of Military History, 1989, 1-6.
7. *Ibid*.
8. Kathryn McIntire Peters, "Civilians at War," *Government Executive*, Jul 96.
9. Zamparelli, 10.
10. Peters, 24.
11. *Ibid*.
12. Zamparelli, 11.
13. Zamparelli, 12
14. "Outsourcing and Privatization," Defense Science Board Task Force, Office of the Under Secretary of Defense for Acquisition and Technology, Aug 96, 7A.
15. *Ibid*.
16. "Improving the Combat Edge Through Outsourcing," *Defense Viewpoint*, Vol 11, No 30 [Online] Available: http://www.defenselink.mil/speeches/1996/s19960301-report.html, 21 Feb 99.
17. Michael E. Ryan, "Notice to Airmen," No 1, Washington DC: Chief of Staff, United States Air Force, Pentagon, 1999.
18. Col R. Philip Deavel, "The Political Economy of Privatization for the American Military," from *Sourcing the Competitive Edge*, ed, Lt Col James C. Rainey and Capt Jonathan L. Wright, Maxwell AFB, Alabama: Air Force Logistics Management Agency, 1998, 3.
19. *Ibid*.

In today's global environment, the Air Force needs to be on location and ready to fight and sustain the mission within days.

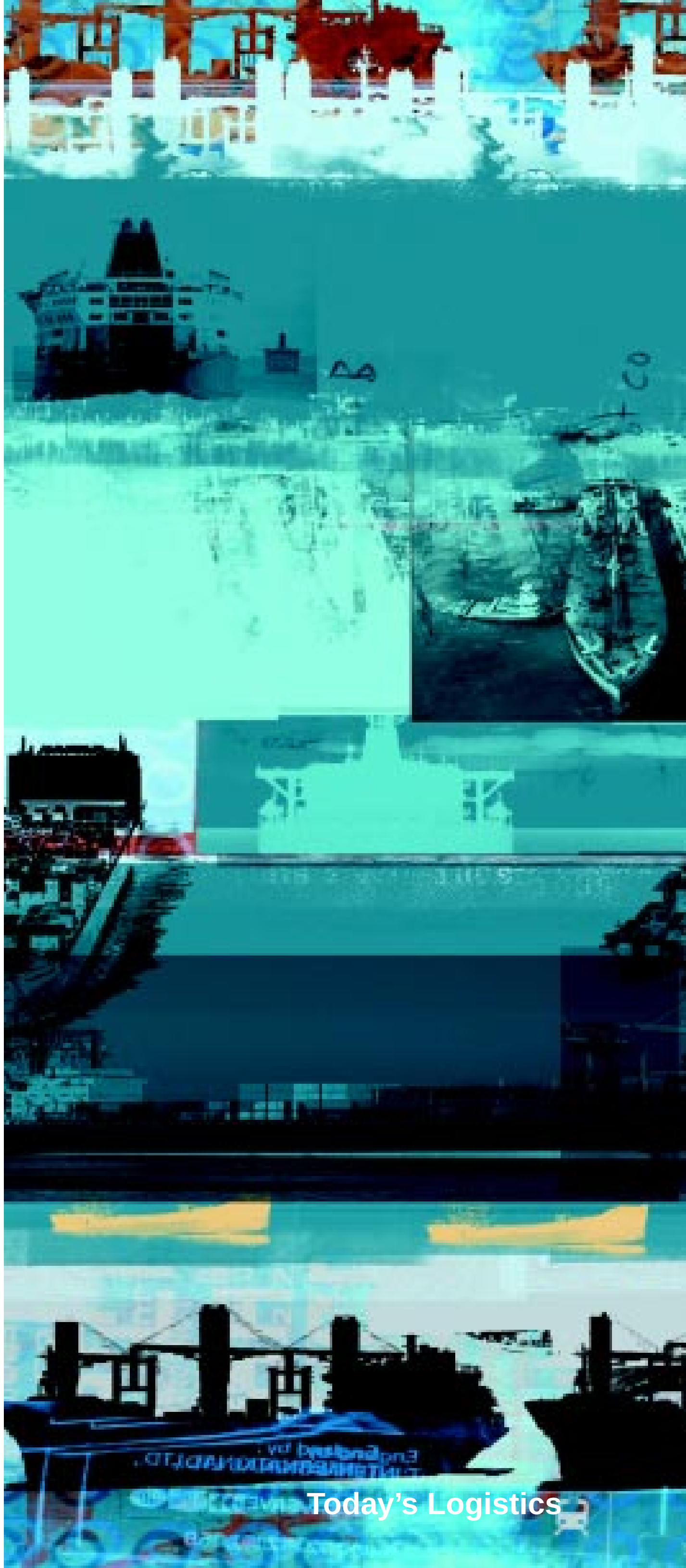
prepositoning AFLOAT prepositoning

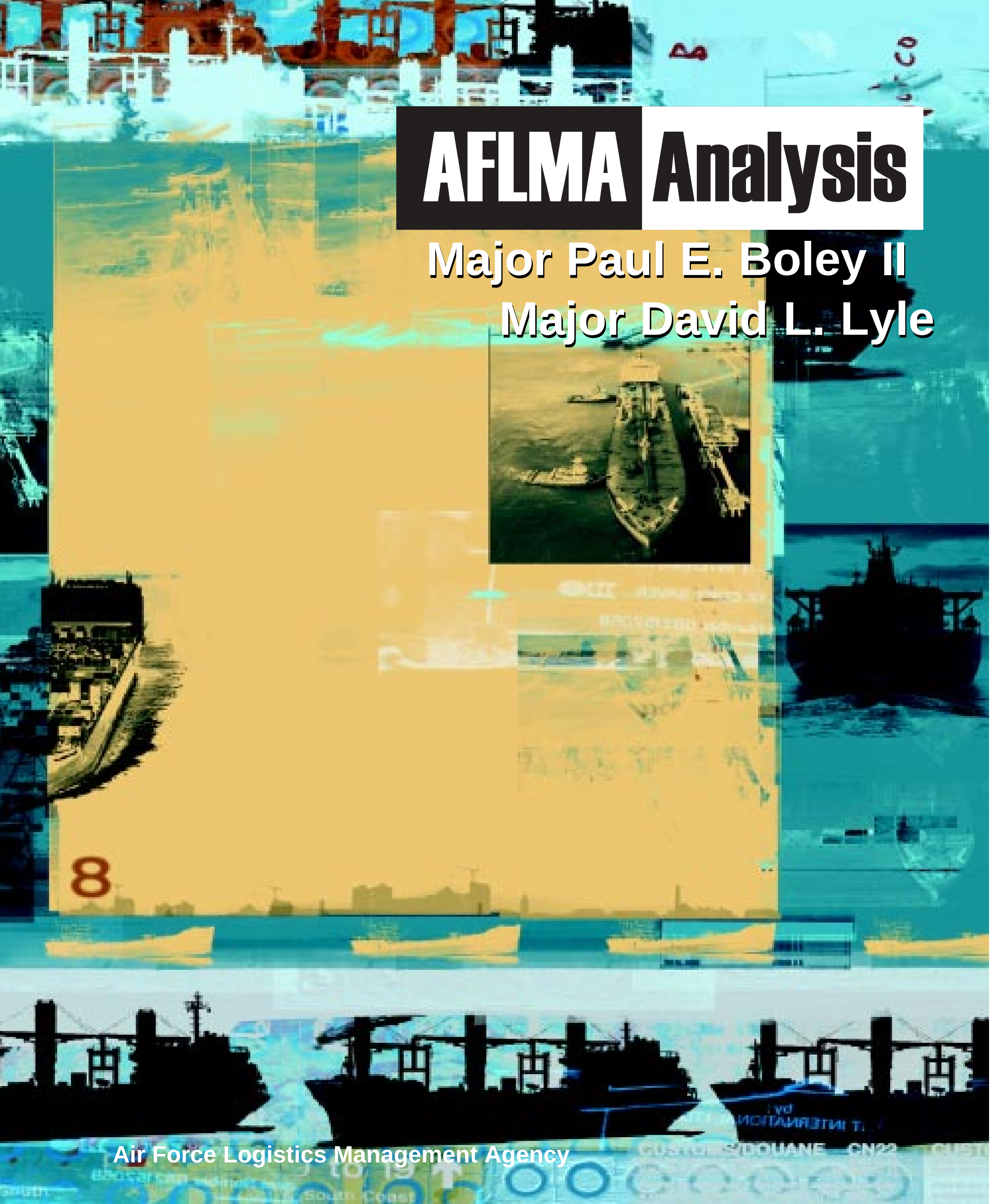
The Air Force concept for initial support of deployed units consists of two prongs. The first is unit equipment, the gear that units bring from home station via strategic airlift. The second is prepositioned war reserve materiel (WRM) assets. Several dynamics affect decisions on the size, content, and location of prepositioned WRM. The chief considerations are airlift availability and global threats.

WRM is currently prepositioned using the *starter/swing* concept. The principle behind starter/swing is sharing resources that are positioned to meet current threats while maximizing flexibility. Starter stocks are assets required at or near the point of intended use until air and sea lines of communication are capable of sustaining operations. Swing stocks are the total requirements, minus the starter stocks. They are positioned to maximize flexibility and designed to support more than one theater.

Starter quantities for consumable items, such as engine oil and hydraulic fluid, are based on expenditure-per-sortie factors and planned sortie rates and durations. Determining starter quantities for nonconsumables such as support equipment, bare-base systems, and vehicles is not as clear-cut. For example, the starter quantity for support equipment is based upon time-phased force deployment data (TPFDD) shortfalls such as lack of available airlift or the inability of airlift to meet aircraft closure times. Bare-base starter stock is based on base population and aircraft base operating support (BOS) requirements. Special and general-purpose vehicle starter quantities are based on BOS requirements and TPFDD throughput.

Ideally, starter stocks are stored at the location where they will be used. Swing stocks should be





AFLMA Analysis

Major Paul E. Boley II
Major David L. Lyle

strategically located to maximize flexibility. Oftentimes, however, there is insufficient storage at these critical locations. WRM must then be *malpositioned*—stored at less than optimum locations.

Strategic Airlift Capability

To date, the Air Force has relied upon a well-developed, global, en route structure and airlift to ensure rapid deployment of unit equipment and malpositioned WRM. However, from 1997 to 2006, the Air Mobility Command (AMC) will lose 131 airlifters from its fleet. Much of this loss will occur with the retirement of the aging C-141 and replacement with fewer, though more capable, C-17 aircraft. As AMC Strategic Plan 2000 points out, “This loss of 131 total tails represents a significant loss in global flexibility to respond to multiple mission taskings.”[1] Simply put, fewer aircraft means delivery to fewer destinations at any given time.

In addition to the loss of global flexibility, the Air Force may find itself in a situation where airlift availability is limited due to competition for space from the other Services. The Air Force does not have a monopoly on airlift requirements. The Army has a significant requirement for strategic airlift. If this requirement occurs at the same time as an Air Force deployment, the deployment time line may be adversely affected. An example of the strain that Army movements can put on the global mobility systems is Task Force Hawk. The movement of Army helicopters and support elements during Kosovo required more than 300 C-17 sorties to haul 22,000 short tons of equipment, constituting 44 percent of the entire Operation Noble Anvil airlift effort.[2]

The competition for lift is not likely to go away in the near future. The Army is currently working on a concept to place a combat-capable combined arms brigade anywhere in the world within 96 hours, with the rest of the division following within another 24 hours. This means that in the early hours and days of a conflict *both* the Army and Air Force could potentially tax the airlift system with deployment requirements.[3]

The bottom line to these concerns is the possibility that the Air Force may not always have timely and guaranteed access to the airlift needed to support future expeditionary operations. Thus, it may be prudent to consider other options to reduce Air Force reliance on airlift.

Land-based Prepositioning

One solution to limited airlift and tight timing criteria is forward prepositioning of WRM. This, however, is complicated by today's rapidly changing and complex global environment. There is no guarantee that an accurate prediction can be made as to where the next crisis requiring the employment of US airpower will occur. This is especially true of humanitarian and disaster relief operations. Air Force units may get lucky and find themselves operating out of locations where WRM is prepositioned, but they could just as easily find themselves bedding down in locations where WRM is not readily available.

In addition to the uncertainty about operating locations, future adversaries may employ tactics that deny US forces access to WRM. The Air Force Strategic Plan details *2015 World Trends*, which suggests that forward bases will be more vulnerable and antiaccess strategies will be prevalent. The enemy may employ various tactics to deny free access to WRM. Tactical nuclear, biological, or chemical weapons and acts of terrorism can contaminate storage locations and prevent access or destroy prepositioned assets.[4] In fact, enemy special forces contamination of WRM storage locations was played out in the major Air Force Title X wargame, Global Engagement IV. The game's scenario included a significant impact on force beddown in the conflict region.

Adversaries are not the only obstacles to free access to WRM. Host nations (those that agree to store WRM) may not allow access for various reasons. If the host nation does not support the goals of a US operation, they may not allow movement of assets out of storage. This is certainly possible in today's environment of constantly changing governments and alliances.

For the Air Force to remain relevant to warfighting commanders, it must be able to respond across the entire spectrum of conflict, to include steady-state commitments (for example, Northern Watch, Southern Watch, and Bosnia), smaller-scale contingencies (SSC), *and* transitions to major theater war. Deployment footprint and airlift requirements need to be reduced, and assured lift is necessary to support sustainment. Most important, the Air Force needs timely access to strategic WRM; otherwise, why preposition?

There is a need to allocate WRM stocks in a manner that enhances the Air Force's flexibility to adapt and respond to a wide range of contingencies rapidly and effectively. A possible solution is the one that the Army, Marine Corps, and Air Force munitions community, have selected: afloat prepositioning.

Current Afloat Prepositioning Programs

The afloat-prepositioning concept was developed by the Marine Corps in the early 1980s, enacted as the Near Term Prepositioning Force, and refined in the Maritime Prepositioning Force in the mid-1980s. Approximately 65 percent of Marine Corps-allocated equipment is currently aboard 13 Military Sealift Command (MSC) vessels. The ships are organized into three maritime prepositioning squadrons (MPSRON) stationed at Guam, Diego Garcia, and in the Mediterranean. Each MPSRON is identically configured and designed to meet the requirements of designated Marine air/ground task forces.

The Marine Corps concept is to offload equipment, either in a port or over the shore, and support more than 19,000 people for the first 30 days of a contingency. The MPSRON package includes tanks, howitzers, Hawk/Stinger launchers, trucks, materiel-handling equipment, ammunition, rations, fuel, and spare parts for the operational force. In addition, the ships hold construction equipment, watercraft, and floating causeways for offload and ferrying of cargo.

The Army's program is similar to the Marines'. One major difference is the configuration of cargo aboard ships. Rather than having three *mirrored* sets of equipment matched to specific units, the Army has sets that are matched to particular functions. For example, the *USNS Gordon*, 1 of the Army's 14 ships, is dedicated to support any combat service support or transportation unit. The *Gordon* has equipment for force protection, port operations, transportation, line-haul, maintenance, supply, logistics command and control (C2), fuels and lubricants, and six modules of force provider equipment (a base support package with equipment to sustain a base of 550 people). The *USNS Titus* and the *USNS Gibson*, on the other hand, are dedicated sustainment- stock ships. Other ships in the Army fleet are dedicated to port opening, logistics, engineering, C2, and aviation support.

Both the Marines and the Army ensure their equipment is ready through continuous, at sea, shipboard maintenance. Several contractors are assigned aboard each ship to complete periodic checks and perform preventive maintenance. The ships have areas where engines can be safely run while underway.

In addition to shipboard maintenance, the equipment is taken off each ship every 30 to 36 months in conjunction with the ship's hull recertification. The ships are offloaded at Blount Island Command (BIC), Jacksonville, Florida, for the Marines and Charleston Naval Weapons Center, South Carolina, for the Army. While the ship is sent to another port for drydock inspection, its cargo is inspected. All shelf-life items are rotated and equipment items inspected for serviceability and corrosion. All modernization, preventive, and corrective actions are also completed at this time.

The Marines have 60 days to remove all equipment, perform necessary inspections and maintenance, and reload the ship. During one of the Air Force Logistics Management Agency (AFLMA) study team's visits to BIC, personnel from the Marine Expeditionary Unit designated to use the equipment were deployed to offload, inspect, and test it. These same Marines may someday rely on this equipment in a contingency situation, which provides a hefty incentive to thoroughly inspect and test it. After inspecting and testing, the equipment was sent to maintenance to be readied for reload onto the vessel.

The Army uses a 90-day cycle to offload, inspect, test, and repack its equipment. They do not deploy soldiers for inspecting and testing, 100 percent of the equipment is inspected and tested, and required maintenance is performed by the onsite contractor and depot personnel.

One of the most common concerns voiced about putting Air Force equipment aboard ships is corrosion. Many assume that equipment will be ruined from exposure to the elements. This is not the case. Equipment aboard ships is stored below deck in humidity- and temperature-controlled areas. In fact, if not for the tiedown chains, you would think you were in a land-based equipment warehouse. A visual inspection of the equipment shows little or no corrosion. The vehicles being offloaded are serviceable—no flat tires—and they start right up.

The concept of afloat prepositioning is not totally new to the Air Force. Prior to the Gulf War, the Air Force had a large amount of WRM for Southwest Asia stored aboard three prepositioning ships. The ships held mostly munitions but also carried smaller quantities of vehicles, rations, fuels support equipment, and miscellaneous supplies. All three ships were earmarked to support US Central Command (CENTCOM) and were afloat in the CENTCOM area of responsibility. The afloat-prepositioning concept at that time called for the ships, at the onset of hostilities, to steam to ports for offloading to provide an initial combat capability. During the Gulf War, this capability was successfully demonstrated when all three ships were called upon to support Desert Shield operations.

After the Gulf War, a massive stockpile of munitions existed in Southwest Asia. The need to reconstitute this stockpile led to a complete reevaluation of the Air Force's global munitions positioning strategy. Out of this reevaluation came the requirement to develop a flexible munitions prepositioning capability with particular emphasis on modern, *smart* munitions. In 1994, the Chief of Staff of the Air Force and theater commanders in chief (CINC) approved an afloat-prepositioning concept based on three munitions ships. The munitions cargo on these ships was classified as swing stock and could be used to augment in-theater munitions starter stocks of the first engaged CINC before the establishment of sustainment stocks.

Today, the Air Force's current Afloat Prepositioning Fleet (APF) still consists of three vessels. The APF can meet worldwide munitions requirements in any theater of operations in 2-20 days, depending upon the location of the contingency relative to the ships.[5]

Military Sealift Command Capabilities

Some of the credit for the quality of the afloat-prepositioned equipment goes to the MSC. The prepositioning program at MSC (PM-3) has a staff of 31 civilian and 82 military. PM-3's mission is:

> To provide operationally ready prepositioning ships to the Army, Navy, Air Force, Marine Corps, and Defense Logistics Agency (DLA) through the development and implementation of policies and procedures that ensure readiness, quality assurance, sound financial control, strategic planning, and prudent acquisition and resource management.[6]

In fulfilling its mission, PM-3 contracts for the use of ships to support the Army and the Marines in addition to the Defense Logistics Agency for bulk fuels and the Air Force for the afloat-munitions program. MSC has strict guidelines for the ships that are included in the prepositioning program. Additional requirements may also be specified by the requesting agency.

For example, the Marine Corps mission requires the capability to offload rapidly in port or over the shore. It requested a roll-on/roll-off (RO/RO) ship outfitted with large, modernized cargo cranes, side ramps, and a helicopter pad (CH-53 capable). The ships that MSC provides are tailormade for rapid load and offload, either pier-side or during joint logistics over-the-shore operations.

Another example where MSC has met unique requirements for the user is the ships that MSC provides for DLA. Its requirement was for tanker ships that could store and offload fuel under various conditions. MSC has provided two offshore petroleum discharge system (OPDS) tankers to help meet DLA's requirement for afloat prepositioning of fuel. The two OPDS tankers are capable of offloading in a port or anchoring up to 4 miles offshore and delivering fuel to onshore fuel farms through a 6-inch conduit.

Ship Capacity and Mobility

Two advantages of prepositioning ships for assets besides munitions are readily apparent: capacity and mobility.

The capacity of prepositioning ships is enormous, especially when compared to the capacity of aircraft. Ships currently available for lease through MSC range in size from 600 to 2,400 twenty-foot equivalent units (TEU). One TEU has about 1,180 cubic feet available inside. For comparison, a C-17 has a usable capacity of 8,736 cubic feet. A direct correlation of C-17 loads per ship is difficult because of the many factors that affect the amount of cargo that is loaded on either mode. Depending on factors such as weight-to-volume ratio and configuration of the ship, one large ship could hold as much as 340 C-17 loads. This capacity could take some of the burden off the already overloaded airlift system.

In addition to enormous capacity, prepositioning ships also provide mobility. The ships can be positioned to meet evolving requirements. They can be directed to steam toward potential contingency areas and then loiter for days or months, if necessary. The equipment can be moved close to a hotspot and stay close without being provocative. This can be used as a strategic tool, displaying readiness without committing other resources.

Steaming Times

A common perception of sealift is that it is a very slow mode of transport. Of course, when a C-17, which cruises at 450 knots, is compared to a 16-knot ship, it does not seem like much of a comparison. There is no doubt airlift is the only choice for priority shipments that *must* arrive within hours. However, when there is sufficient lead time or the load is so large it makes airlift impractical, sealift can get the job done.

At 16 knots, a ship stationed at Diego Garcia can get to ports near most potential contingency locations in the world in 12 days or less. Using an aerospace expeditionary force (AEF) time line, with 24 hours' strategic warning and another 48 to the CINC's first significant effects, it seems unlikely that an afloat-prepositioning ship could provide support. However, in most cases, there is an expanded, *ambiguous* warning period. Taking that back even 12 days (to the first intelligence indicators, beginning of posturing, or diplomatic talks), afloat prepositioning becomes a viable option. The Air Force can forward deploy and lean forward. Steaming a ship toward a hotspot is not provocative, yet it shows determination. The ship can be repositioned very early in a crisis and float *just over the horizon* offshore as long as necessary. When it is needed, it can quickly pull into port and begin offloading to provide a massive amount of equipment in the early stages of any contingency.

With afloat prepositioning the *lift, access, and agility* are built in.

Discussion and Analysis

In July 1999, AFLMA began studying the feasibility of putting nonmunitions WRM and other equipment on prepositioning ships. On 28 February 2000, AFLMA and representatives from MSC briefed the Deputy Chief of Staff, Installations and Logistics on the results of the study. The preliminary results indicated that afloat prepositioning is a promising concept. The Directorate of Plans and Integration and AFLMA were tasked to conduct a follow-on study. The tasking requested four areas of analysis:

- A two-part, cost-benefit analysis of both day-to-day and wartime cost-benefits
- A decision support tool to determine when it would be more expedient to use assets prepositioned on ships instead of land-based, prepositioned assets
- A summary of asset condition on Army and Marine Corps ships
- A summary of ship reliability for MSC prepositioning

Literature Review

A number of documents contained valuable information used in either developing the plan or completing the study. In addition to AFLMA's preliminary feasibility study mentioned above, we reviewed a series of Air Force instructions, Army Field Manuals, Concept of Operations (CONOPS) documents, and planning guides, as summarized below.

Air Force Instruction (AFI) 25-101, *WRM Program Guidance and Procedures.* This instruction offers some insight into overall WRM management and designing an effective CONOPS for WRM prepositioned afloat.

> Para 1.1.3: The Air Force WRM program links the positioning of resources with theater air campaigns via the component Air Force War and Mobilization Plan, Volume 4/(WMP-4) Wartime Aircraft Activity Report. Using the starter swing approach, components are authorized WRM consistent with WMP-4 activity, for the approved force structure, over the duration of the starter period.
>
> Para 1.7.2: The major command (MAJCOM)/air component logistics plans division or equivalent should identify WRM consumables, disseminate WRM authorizations and starter/swing objectives to subordinate units, participate in development of theater force beddown, evaluate the logistics impact and cost of proposed beddown changes, direct appropriate planning document updates, and authorize use of WRM.
>
> Para 1.11: Storing commands determine and report the serviceability and availability of assets according to Air Force Manual (AFM) 23-110**,** *USAF Supply.*
>
> Para 2.1.1: The Air Force prepositions to support starter requirements. Swing stocks are positioned to maximize flexibility to support multiple theaters.
>
> Para 2.1.3: Air Force units may use existing WRM assets to support AEF tasking.
>
> Para 3.4.1: WRM is inspected annually.

AFM 23-110, Chapter 14 gives guidance on supply policy regarding WRM and readiness spares packages.

Army Field Manual 100-17-1, *Army Prepositioned Afloat Operations* gives detailed instructions on how the Army manages its materiel prepositioned afloat.

Military Traffic Manage Command (MTMC) Guide 700-2, *Logistics Handbook for Strategic Mobility Planning* is used by planners and gives a broad range of transportation planning data and guidance for mobilizing, deploying, and sustaining US forces worldwide, including planning factors used to estimate the time to load, ship, and unload cargo.

MTMC *Ports for National Defense.* This CD is another planning tool used by MTMC and provides throughput capability of ports throughout the world.

AFI 65-508, *Cost Analysis Guidance and Procedures* provides Air Force guidance on how to conduct cost-analysis.

AFI 10-400, *AEF Planning* provides Air Force guidance on planning for AEF employment but does not refer to WRM.

Central Command Air Forces (CENTAF) AEF CONOPS, provides the baseline AEF force used to build the proposed WRM-Afloat load, planning factors, and the timing goals. Chapter 6 makes specific reference to planning for and using WRM to support AEFs.

USCENTAFI 25-101 contains a detailed vehicle package to support an AEF. This package was used as the baseline, tailored to obtain a proposed WRM-Afloat vehicle load.

Defense Planning Guidance (DPG) 2000-2005 Scenario Appendix describes DPG-approved scenarios to measure the effectiveness of the WRM strategies.

Manpower and Equipment Force Package System summary report is an important source of data used by all logistics planners. It contains planning factors, including weight, for standard unit type codes.

Agile Combat Support CONOPS, 1 October 1999, provides background information on the direction of future deployment and sustainment plans.

AFI 65-503, *Cost and Planning Factors*, contains logistics cost factors, including Department of Defense (DoD)-approved cost factors for cost per flying hour and unit flyaway costs for Air Force platforms.

At the same time AFLMA was beginning this study, the Mobility Requirements Study 2005 (MRS-05) was being completed. The following paragraphs summarize the history of the MRS studies and their significant conclusions.

Mobility Requirements Studies and Guidance

The Mobility Requirements Study 2005 (MRS-05) is the third in a series of major mobility studies DoD has undertaken since the end of the Cold War.

The first one, the Mobility Requirements Study, conducted in 1992, was motivated by concerns about DoD strategic mobility capabilities after Operations Desert Shield and Desert Storm. It developed mobility requirements through FY99 for a single major regional conflict (MRC). The MRS influenced the acquisition strategy for many of the programs that are currently the backbone of today's strategic mobility program, including the large, medium speed, RO/RO vessel; the C-17 aircraft; prepositioned stocks; and the Army Strategic Mobility Program.

In 1994, the bottom-up review (BUR) introduced the concept of two, nearly simultaneous MRCs. This change in the national security strategy affected the continued validity of many strategic mobility assumptions in the MRS and led to a follow-on review, known as the MRS BUR Update (MRS-BURU), published in March 1995.

The national military strategy has continued to evolve since the MRS-BURU, including an increased emphasis on SSCs, a significant reduction in the number of overseas bases, changes in service force structure, and changes in the international environment. MRS-05 showed the impact of responding to threats from a posture of global engagement in an environment where the enemy uses asymmetric attacks, including weapons of mass destruction (WMD), on friendly transportation nodes.

The executive committee for MRS-05 consisted of the Director J4; Director J8; Director, Program Analysis and Evaluation; the Assistant Secretary of Defense (Strategy and Threat Reduction), and the deputy commander in chief, United States Transportation Command. MRS-05 evaluated the FY05 programmed force structure as documented in Services and Special Operations Command program objective memorandums for FY00-05. These forces are used to wage war consistent with scenarios described in the DPG 2000-2005 illustrative planning scenarios (IPS) for major theater war (MTW)-West/East and MTW-East/West. The threat encountered in these scenarios is consistent with the June 1998 Defense Intelligence Agency projections for FY05. Included in this projection are chemical and Special Operations Forces attacks against air and seaports of debarkation, as well as mine and submarine threats against seaport approaches. In deploying the forces, MRS-05 assumed that US forces were in a posture of engagement as detailed in the DPG IPS Posture of Engagement scenario.

The MRS-05 identified three future force structures. Case 1 is the programmed force structure using the CONOPS. Case 2 kept the current force structure but changed the CONOPS to improve force closure rates. Case 3 included money to buy additional resources, including a number of C-17s. These cases were evaluated by measuring their ability to complete the CONUS, intertheater, and intratheater movements along with their impact on warfighting. The enhanced logistics intratheater support tool was used to evaluate the CONUS and theater portions of transportation. The Model for Intertheater Deployment by Air and Sea was used to measure intertheater movements. The Tactical Warfare Model was used to evaluate warfighting measures. The measure of merit for the movement parts of the analysis was the force closure profile, while the measure of merit for the warfighter was risk in achieving key objectives.

In order to conduct this analysis, unit deployment requirements were represented by time-phased force deployment data of notional units similar to that used in the development of conventional deliberate war plans in the Joint Operating Planning and Execution System.

MRS-05 Preliminary Findings. The MRS-05 study found the force structure being moved was significantly heavier than the force structure moved in the MRS-BURU and about the same size as the forces moved during Desert Shield/Desert Storm. Table 1 shows the movement requirements used in previous studies for Southwest Asia and Northeast Asia. The data in this table have been normalized with Desert Shield/Storm ammunition set to 100. Tonnage is broken down by unit equipment, ammunition, and resupply.

MRS-05 Findings. There were no significant findings identified in the MRS-05 analysis of

	SWA			NEA		
	UE	Ammo	Resupply	UE	Ammo	Resupply
MRS-BURU	212	86	68	117	61	49
DS/DS	290	100	101	NA	NA	NA
MRS-05	280	84	118	184	72	129

Table 1. Movement Requirement (in thousands of short-tons) by Study (data normalized)

CONUS movement that would affect conclusions regarding the utility and feasibility of positioning WRM afloat. With respect to intertheater and intratheater movement, the MRS-05 found a need for more airlift as well as a need to better respond to enemy WMD. The analysis also covered sealift and revealed that afloat prepositioned material arrived in time to support the *Halt* phase for the first MTW. WRM equipment preopositioned on land, however, did not always arrive at theater beddown location due to intratheater lift problems.

Implementation Issues

Mission Need. In all the references to Agile Combat Support and AEF planning and execution, it is clearly stated that WRM prepositioning is vital. AFI 25-101 states that (1) the prepositioning strategy provides the best support for starter requirements possible and (2) swing stocks "maximize flexibility to support multiple theaters."

Scenarios, The DPG illustrative planning scenarios and all the US operations since 1990 were used as benchmarks to determine the effectiveness and robustness of the WRM-afloat concept.

The DPG illustrative planning scenarios contain ten *illustrative planning scenarios* and nine *longer range* scenarios. The ten illustrative planning scenarios depict the types of military challenges that might be encountered during the Future Years Defense Program or FY00-05. These scenarios provide benchmarks for components to use in programming levels of readiness, sustainability, support, and mobility. They also serve as an analytic tool for evaluating component programs submitted for review. These scenarios provide an approved, credible, consistent starting point so the components can examine the impact of DPG guidance on the complete range of their capability development activities. These scenarios neither predict the future nor exhaust the possible challenges to US security interests during the planning period. The force allocations for each scenario depict a plausible US response under the stated condition. However, agencies should not construe these allocations as indicative of future force assignment or apportionment decisions. The longer range scenarios are provided for programs to use as a starting point for analysis of program impacts for the 2010-2020 period.[7]

For information on US operations since 1990, unclassified information available from the Federation of American Scientists web site was used.[8]

Threats. The following threats to WRM were identified:

- Direct attacks on WRM prepositioning ships
- Terrorist attacks against fixed storage sites
- Terrorist attacks against the aerial ports of debarkation (APOD)/seaports of debarkation (SPOD)
- Theater ballistic missile (TBM) attacks against fixed storage sites
- TBM attacks against the APOD/SPOD
- Interdiction of the sea lines of communication
- Interdiction of the line haul between SPOD and the final destination
- Failure to secure political permission to use APOD/ SPOD

Description of Alternatives. Two alternatives were compared. In both alternatives, it was assumed that funding was provided to create a *well* WRM system (all WRM authorizations are filled). The alternatives are:

Alternative 1: Fully Funded WRM System. All WRM equipment is stored in appropriate facilities at existing loc*ations. T*his alternative is not the same as the *current* WRM system for several reasons. First, this alternative assumes a well system with all authorizations funded and filled, whereas the current system has a significant amount of unfilled authorizations. Second, this fully funded system stores the WRM in proper facilities, whereas the current system lacks adequate storage for some WRM assets.

Alternative 2: Afloat. This alternative is the same as Alternative 1 with the exception that some WRM equipment in the fully funded system is taken from CONUS and prepositioned afloat, vice stored on land. This reduces the amount of money that is required to build and maintain land-based storage for that WRM equipment. This savings, however, is offset (as will be shown) by the costs of leasing ships.

Nonviable Alternatives. The following alternatives were not considered for the reasons discussed below:

- Changes in the size and capability of the air/sealift fleets. This is more appropriately addressed by other studies.
- Changing the current WRM storage network other than to place some WRM afloat. While this may be a desirable study objective, it is beyond the scope of this analysis.
- With the exception of the MRS-05 analysis, taking WRM from overseas theater stocks and prepositioing it afloat. The team saw theater prepositioned stocks as the first choice of any theater CINC. It viewed WRM prepositioned afloat as swing stock that would either augment existing theater prepositioned WRM or serve as an alternative to theater prepositioned WRM if the United States were denied access to it or not able to transport it to the location of intended use.
- Reducing the size of WRM footprint. This option is addressed by other initiatives.
- Mixing WRM afloat with the existing munitions afloat. Although this is an alternative recommended by MRS-05 analysts, it would have required additional time

beyond the time line established for this analysis and was not considered.

Effectiveness Measures

Mission Tasks. Mission tasks (MT) describe the *general* functions to be performed to satisfy the mission. The *specific* nature of the tasks is captured by the measures of effectiveness (MOE), which are developed to measure success in performing the tasks. The purpose of the WRM infrastructure is summarized by two mission tasks:

- MT-1. Peacetime: storage and maintenance
- MT-2. Wartime: deploy and support contingency

Measures of Effectiveness. A number of measures were derived to compare the ability of the two alternatives to accomplish the mission tasks. These MOE are listed in Table 2.

Conclusions and Recommendations

Conclusions

For the peacetime analysis, up-front costs for land-based prepositioning in CONUS exceeded those for afloat prepositioning by nearly $6.6M. This was due to the requirement for additional land-based warehousing. Over a 5-year lease period, yearly expenditures for afloat prepositioning, however, exceeded those for land-based CONUS prepositioning by $8.2-12.4M depending on the level of recurring and preventive maintenance conducted each year.

During wartime, the ship quickly paid for itself. Three hypothetical excursions were run involving conflicts in Southwest Asia, the Pacific, and Europe with afloat prepositioning resulting in savings of $7.3M, $12.1M, and $6.7M, respectively, over land-based prepositioning.

Regarding force-closure timing, the MRS-05 analysis results indicated that equipment aboard the ships was delivered to the operating location within required time lines. The net impact of the nonmunitions WRM-afloat prepositioning ship was to shorten the force closure time line by 1 to 2 days over the first 15 days of the operation. One prepositioning ship provided the same impact as three to four C-17s. For the remaining non-MTW scenarios, 73 percent had sufficient unambiguous warning time to allow the ship to support the operation—*assuming a timely decision by senior commanders to allocate and sail the ship.*

Afloat asset and ship reliability were extremely high with overall rates of 99 percent and 95 percent, respectively.

A hierarchical decision support tool was developed with the following order of preference: (1) in-place equipment, (2) malpositioned (in theater) equipment, (3) afloat equipment, and (4) airlifted equipment. Throughout the various steps of the decision tree, timing becomes a critical element in deciding how best to support a given contingency.

Purchasing $71M in new equipment to put on a ship is cost prohibitive based on past Air Force WRM budget appropriations. As mentioned previously, due to theater CINC mission-impact concerns, analysis for this study was not predicated on taking current on-hand assets from theater CINC. If current on-hand assets are used or if a situation arises where a large amount of WRM becomes available (for example Korean reunification), the $71M requirement to purchase new equipment no longer exists.

Recommendations

Short-term (2001-2002):

- Validate MAJCOM MTW WRM authorizations, redistribute, identify shortages
- Study alternative strategies for obtaining assets for an afloat package
- Develop a contingency plan for possible loss of an overseas storage site

Long-term (2002-2008):

- POM for validated shortages
- POM for lease of one ship

MOE 1.1	Peacetime Costs
MOE 2.1	Contingency Costs
MOE 2.2	Force Closure Rate
MOE 2.3	Usability Risk
MOE 2.3.1	Afloat Equipment Reliability
MOE 2.3.2	Ship Reliability
MOE 2.3.3	Proximity of port to conflict (Qualitative)
MOE 2.3.4	Warning time vs steaming/unload/line haul time (Qualitative)
MOE 2.3.5	Political access to ports (Qualitative)
MOE 2.3.6	WRM load compared to force needs (Qualitative)
MOE 2.3.7	Contingency Interdiction Risk (Qualitative)

Table 2. Measures of Effectiveness

- Develop an implementation plan to place one package of WRM assets afloat
- Execute the implementation plan if funding becomes available

Notes

1. Department of the Air Force, *Air Mobility Strategic Plan 2000*, Scott AFB, Illinois: Headquarters Air Mobility Command [Online] Available: http://amc.scott.af.mil/xp/index.htm, 8 Feb 00.
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AFLMA Analysis

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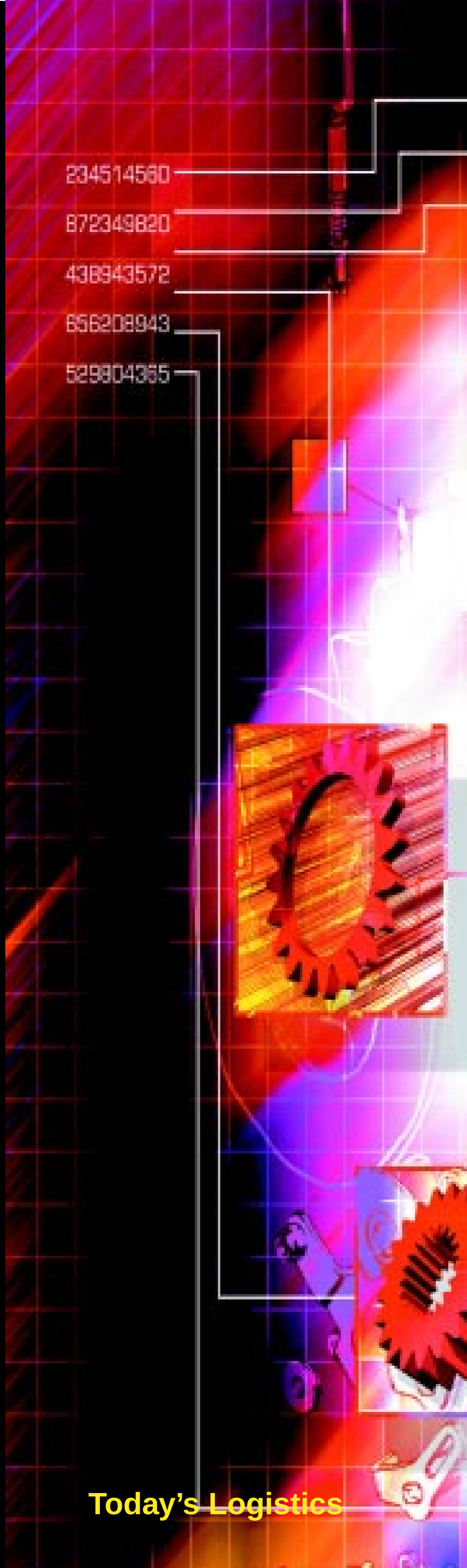
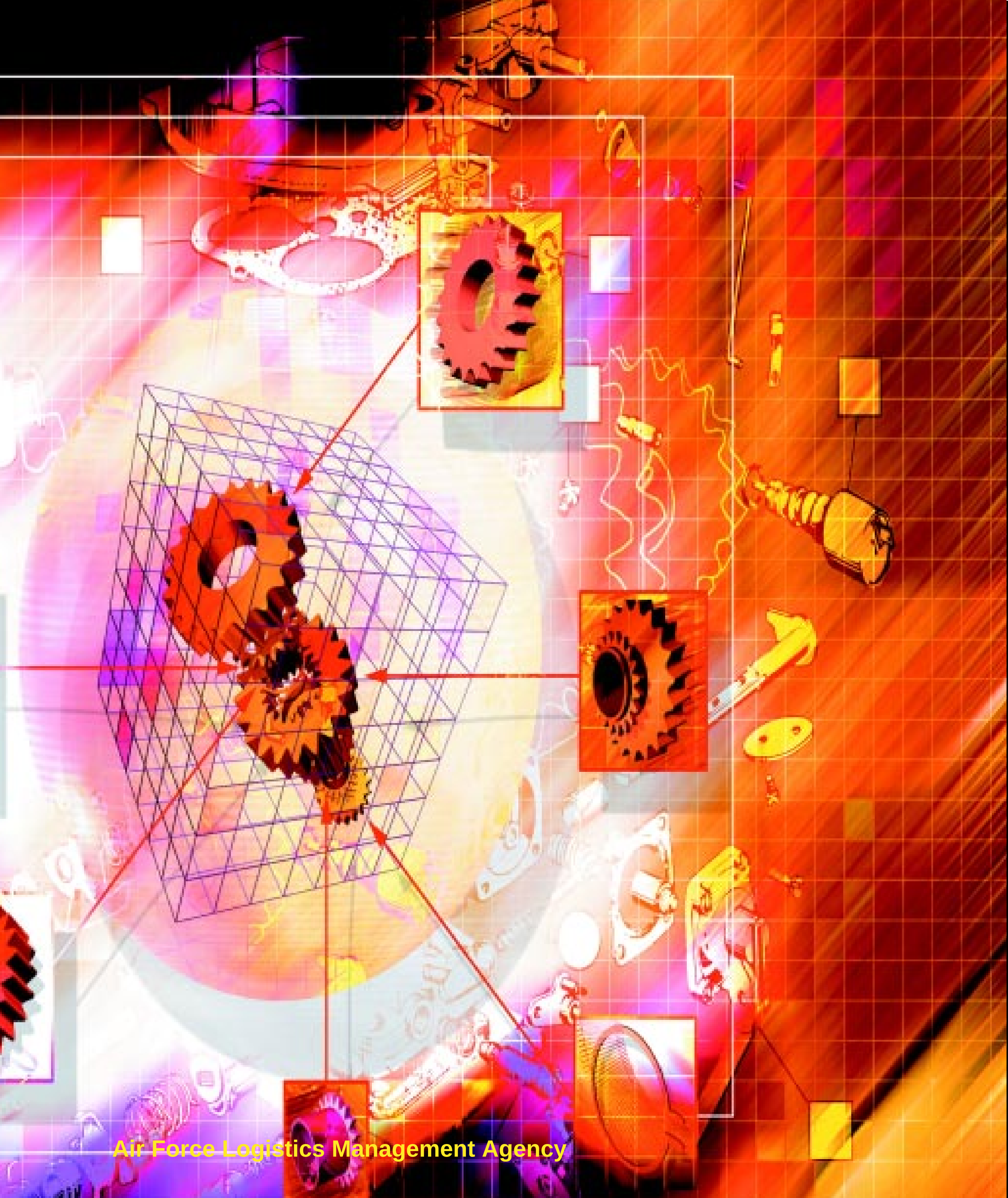
Retail Retention Policy

To attain DMRD 987 goals, the Air Force created the Air Force Inventory Reduction Program. Goals of the AFIRP included streamlining inventory management processes, accelerating disposal of assets, reviewing pipeline times, implementing tighter screening of buys and repairs, reducing adjusted stock levels, and reviewing *retention policies at the retail level.*





Background

Department of Defense (DoD) inventory levels of secondary items, defined as spare parts to support weapons systems as well as personnel support commodities—subsistence, medical materiel, and clothing—have experienced a roller coaster ride over the last 30 years. In the 1970s, inventory levels were at or near historical lows. It was during this period that aircraft were grounded and other weapon systems were often found to be not mission capable (MICAP) because of spare parts shortages. However, inventory levels rose dramatically during the 1980s. The increases of the 1980s were supported by congressional efforts to improve force

The purpose of this analysis was to determine if Air Force retention policies implemented to trim inventory levels are disposing of items too quickly. Specifically, it focuses on select budget code 9 items.

readiness and capabilities. Then came the 1990s. The Cold War bipolar alliances gave way to a world where regional interests dominate. At the same time, Service force structures were drastically reduced and weapon-system, spare parts inventories slashed. Throughout the 1990s, all the Services scrambled to resize inventories while maintaining readiness.

A guiding force behind resizing efforts was DoD's Defense Management Review Decision (DMRD) 987, *Inventory Reduction Program*, issued in May 1990. DMRD 987 focused on reducing inventory, reducing the budget, minimizing new buys, and improving processes.

To attain DMRD 987 goals, the Air Force created the Air Force Inventory Reduction Program (AFIRP). Goals of the AFIRP included streamlining inventory management processes, accelerating disposal of assets, reviewing pipeline times, implementing tighter screening of buys and repairs, reducing adjusted stock levels, and reviewing *retention policies at the retail level.*

The purpose of this analysis was to determine if Air Force retention policies implemented to trim inventory levels are disposing of items too quickly. Specifically, it focuses on select budget code 9 items.

Two sources drew attention to the Air Force retention policy for these items. The Air Mobility Command (AMC) asked the Air Force Logistics Management Agency (AFLMA) to analyze why some parts for mature weapon systems were experiencing first and second time demands (cause code A and B). AMC suspected these were, in fact, not first- or second-time demands but, rather, a lack of sufficient demand history within the supply system for previous demands. It asked that the issue be addressed from two perspectives: demand forecasting and retention. This analysis addresses the retention perspective. AFLMA project number LS20009600, *Analysis of Low-Demand Items for Mature Weapons Systems*, will address the issue from a demand forecasting perspective.

Around the time of the AMC request, the 51st Logistics Group commander at Osan AB presented the Air Force Chief of Staff with a point paper concerning retention of consumable aircraft parts. The paper's thrust was that consumable aircraft items were being disposed of too quickly; that is, items were demanded after they were disposed of. The paper recommended a review of Defense Logistics Agency (DLA) and Air Force Standard Base Supply System (SBSS) retention policies for these items.

Analysis

Discussion

Retail asset retention is an often-analyzed topic. In fact, in the recent past, AFLMA conducted four studies on this subject. The recommendations from these study efforts resulted in the current retention policy. However, the results were hindered by a lack of data—only 4 years of data could be used. This analysis used data over a 12-year period and, as a result, captured much broader demand histories.

As a reference point, the following paragraphs provide an overview of SBSS retention policies for budget code 9 items.

Current SBSS retention policy governing budget code 9 items can be summarized as follows.

The retention period for excess materiel starts when an item is assigned a serviceable asset retention start date (SARSD), also known as the date stockage priority code (SPC) 5 assigned. The retention period (defined as the time from the SARSD until an item becomes disposal eligible) is determined by the mission impact code (MIC) assigned to the item record. A MIC is assigned to an item based on the highest urgency of need designator (UND) customers use to place demands. Table 1 shows the relationship between MICs and UNDs as well as the retention period for each MIC.

So MIC 1 and 2 items are retained for 2 years (without demands), and MIC 3 and 4 items are retained for 1 year (without demands) *from the SARSD*.

As mentioned, the stockage priority code determines when the retention period starts. The SPC is very similar to the mission impact code, except the SPC migrates up or down depending on the timing and UND of the due-out. Conversely, the MIC is never downgraded. Table 2 provides an SPC matrix.

Table 2 illustrates the relationship between the SPC and the UND (or urgency justification code) used to back order an item. Also, the third column (Downgrade if Period w/o Demand =>) shows the number of days without a demand that an item will maintain a particular SPC. The SPC is updated based upon demand activity and priority of back orders each time file status is processed. When file status runs, if the difference between the date of last demand and the current date is greater than the number of days shown in column three, the SPC is downgraded by one. For instance, if file status runs and an SPC 1 item had no demands in 115 days, the SPC would be downgraded to SPC 2.

The SPC influences the time between demands before an item is identified as excess, regardless of MIC. For example, a MIC 1 item with SPC 1 takes 15 consecutive months without a demand before it enters the retention period and is assigned a

MIC	Urgency Need Designator	Type Request	Retention Period
1	1, J, / or UJC 'AR'	MICAP or AWP	730 days
2	A, or UJC 'BR'	Non-MICAP, High Priority	730 days
3	B	Delayed Discrepancy/Mission Impaired	365 days
4	C	Routine	365 days

Table 1. Mission Impact Code Matrix

SARSD. On the other hand, a MIC 1 item with an SPC of three takes only 9 consecutive months without a demand to enter the retention period. Since both items are MIC 1, their retention periods will be the same, 24 months. So the SPC influences the time it takes to enter the retention period but not the length of the retention period.

With the above in mind, it takes items with MIC 1 and SPC 1 a total of 39 consecutive months without demands to be eligible for disposal (transfer to the Defense Reutilization and Marketing Office (DRMO)). But MIC 1 items assigned an SPC of three take only 33 consecutive months without demands to be eligible for disposal.

When an item *enters* the retention period, the excess quantity is reported to the source of supply (SOS). The SOS replies to the base-level excess report and directs one of three actions: (1) redistribute the excess quantity to another base, (2) return the excess quantity to the SOS, or (3) determine disposition locally. If the SOS directs local disposition, the excess quantity is usually sent to the DRMO at the end of the retention period. Procedures in Air Force Manual (AFM) 23-110, *USAF Supply Manual*, allow retail supply managers to retain items beyond their retention period when warranted.

SPC	Urgency Need Designator	Downgrade if Period w/o Demand >
1	1, J, / or UJC 'AR'	90 days
2	A, or UJC 'BR'	90 days
3	B	90 days
4	C	180 days

Table 2. Stockage Priority Code Matrix

Methodology

The data source for this analysis was the Air Force Supply Data Bank (AFSDB)—maintained by AFLMA. As prescribed in AFM 23-110, Volume II, Part Two, Chapter 1, select base supply accounts submit various supply data to the AFSDB on a monthly and semiannual basis. The data are archived and used by AFLMA to conduct studies and analyses.

This analysis used demand data from six Air Force base supply accounts (Langley, Minot, Kunsan, Charleston, Dover, and Elmendorf) over a 12-year period (March 1988 to March 2000). Historical data availability and weapon systems supported were the main factors used to select these bases. The time period was limited to 12 years because that is as far back as AFSDB records go.

Items selected for this analysis met the following criteria: system designator of 01; type stock record account number of B; and an expendability, recoverability, reparability code of XB or XF. Additionally, none of the item records used were L or P serialized stock numbers or coded as hazardous material (issue exception code 8 or 9). Using this criteria, 571,541 items were selected.

Relevant Costs. Two cost factors—repurchase and retention costs—played a major role in the analysis. *Repurchase costs* are costs incurred to repurchase an item no longer available because excess quantities exceeded the retention level and were disposed of. Repurchase costs were computed at the net present value (using 8 percent as the cost of capital) of the most recent acquisition price of each item. *Retention costs* included both *storage* costs and *disposal revenue lost*. Storage costs were computed as 1 percent of the warehoused inventory dollar value. DoD 4140.1-R *Materiel Management Regulation*, 1 May 1998, recommends using 1 percent to compute storage costs for fixed supply points (for example, an Air Force base), unless there is convincing evidence to use a different method. *Disposal revenue lost* was computed as 2 percent of an item's acquisition price at the time it met disposal criteria. On average, the salvage value of DoD items ranges from 2 to 3 percent of an item's acquisition price. By holding items in storage rather than sending them to DRMO, this revenue is lost.

Selection and Grouping of Applicable Items. Demand data from three fields on the item record were used: number demands current, number of demands in the last 6 months, and number of demands in the last 7-12 months. Demands stored in each field were strung together to represent 12 consecutive years of demands for each stock number selected. This allowed identification of items that exceeded current retail retention periods.

Analysis Results

Reducing Cause Code A and B Due-Outs and Preventing Premature Disposal of Assets. Once all potential excess items were identified—items that exceeded the current retail retention period—the analysis focused on items with at least 36 months between demands. As mentioned earlier, demand data are stored on the item record detail in 6-month segments. Further, an item coded SPC 1, MIC 1 must go 39 months without demands before being transferred to DRMO. Since 39 months is not divisible by 6 months, 36 months was used as the cutoff. This assumes that most MIC 1, SPC 1 items without a demand in 36 months would go an additional 3 months without a demand.

To get a baseline, the number of items with subsequent demands and their related dollar values was totaled. Table 3 provides the results.

From the six bases, 192,410 items had at least a 36-month gap in demands. Of those items, 17 percent (32,358/192,410) experienced at least one demand after exceeding current retention periods. The remaining 83 percent (160,052/192,410) did not. For these six bases, that means 32,358 items met disposal criteria and had a subsequent demand. For the purpose of this analysis, we assumed that items meeting disposal criteria were disposed of. Therefore, these 32,358 items experienced future demands (back orders) that were identified as cause code A or B due-outs. This indicates extending current retention periods will reduce cause code A and B due-outs and prevent premature disposal of assets.

Reducing MICAP/Awaiting Parts (AWP) Incidents. To determine cost benefits and find the optimum retention period, the point in time when retention costs would exceed repurchase cost was calculated. Figure 1 displays the results in 1-year segments.

As Figure 1 illustrates, the cost to retain all (192,000) items never exceeded the estimated repurchase costs of items demanded (32,000). Cumulative repurchase costs (benefits) easily exceeded retention costs.

These results show that for the sample group of items, during that 12-year period, it was cost effective to retain items without a demand for at least 8 years (36 months plus 60 months). Based on these results, it appears beneficial to extend retention periods on all items. However, the benefits identified could be attributed to certain items—the 32,000 items with subsequent demand.

The question now becomes, is there a way to better forecast items most likely to have a subsequent demand and not retain all 192,000 items? During the analysis, the number of items with subsequent demands, their estimated repurchase and retention costs, and the amount that repurchase costs exceeded retention costs were stratified by mission code. Table 4 shows the results.

MIC 1 and MIC 2 items account for 96 percent ($2.4M/$2.5M) of the total repurchase costs and 88 percent ($1.353M/$1.543M) of the total retention costs. So the cost differences identified in Figure 1 are derived mostly from MIC 1 and 2 items. Twenty-five percent (13,000/52,000) of MIC 1 and 17.5 percent (14,000/80,000) of MIC 2 items had subsequent demands.

Forty percent (13,038/32,358) of the items with subsequent demands at least 36 months apart were MIC 1 items—mission critical, MICAP-causing items. Forty-four percent (14,076/32,358) of the items were assigned a MIC 2—significant mission limiters. Combined, their repurchase costs were $2.4M. So not only did the sample bases dispose of assets of significant value to their various missions, but the repurchase cost of these items also exceeded the retention cost by $1.0M ($.823M+$.216M).

Combined, MIC 3 and MIC 4 items constituted only 16 percent (5,244/32,358) of the items with future demands. Their combined retention costs exceeded repurchase costs by $39K. Therefore, it is not advisable to retain MIC 3 and 4 items for more than 3 years without demands. Retaining MIC 3 and MIC 4 items for a shorter period of time will be addressed subsequently.

The six sample bases disposed of 13,038 mission critical items (Table 4) for which they experienced a future MICAP or awaiting parts (UJC AR) demand. That equates to 13,038 MICAP or AWP preventable incidents, over a 12-year period, directly attributable to premature disposal of infrequently demanded items. Thus, increasing the current retention period will decrease MICAP/AWP incidents. Also, repurchase costs exceeded retention costs by $999K. So it is cost beneficial to retain items for at least 8 years between demands.

Figure 1 showed the *cumulative* amount repurchase costs exceeded the retention cost for 5 years beyond the current retention period. In Table 5 the *cumulative* number of items with subsequent demands and related difference in costs (amount repurchase costs exceed retention costs) by the number of years between demands are stratified. The results are grouped by MIC.

	Number of Items	Dollar Value	Number of Items with Subsequent Demands	Dollar Value of Demanded Items
6 Bases	192,410	$25.6M	32,358	$2.9M

Table 3. Items with at Least 36 Months Between Demands

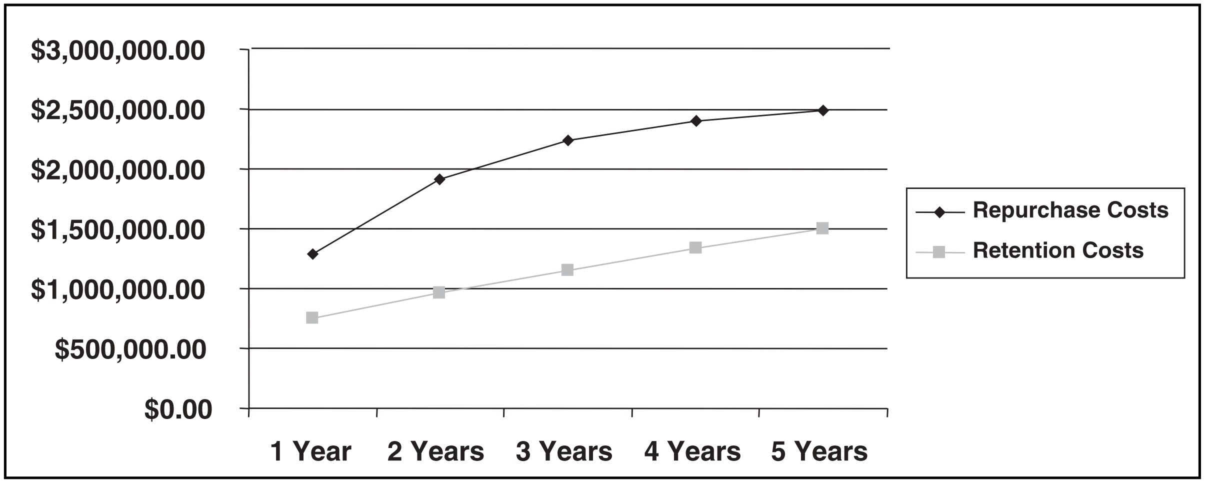


Figure 1. Repurchase Costs of Items Demanded Compared to Retention Costs of All Items (Totals for All Six Bases)

The delta (repurchase costs minus retention costs) decreased in year groups 7-8 for MIC 1 items and 6-7 for MIC 2 items. For example, examine the highlighted row of MIC 1 items. There, the cumulative repurchase costs are $837K more than cumulative retention costs. However, the very next year, the difference decreases to $792K, indicating retention costs in the 7-8-year period exceeded repurchase costs by $45K ($837K-$792K). The same is true for MIC 2 items. MIC 4 items were more expensive to retain than to repurchase in each period. To further illustrate this, Table 6 provides the same data as Table 5, except the data are not cumulative. Instead, the data are applicable only to the year shown. This identifies the cost/benefits by time period.

Table 6 illustrates how benefits in earlier years compensate for costs in later years. Note that 1,209 MIC 1 items experienced at least 73 but no more than 84 months between demands, and their repurchase costs exceeded retention costs for that period. Although the delta for MIC 1 items in the 73-to-84-month period is only $1K, the importance of MIC 1 items and the high number of items (1,209) demanded substantiate their retention. Retaining MIC 1 items more than 7 years is not cost beneficial. Therefore, MIC 1 items should be retained for, at most, 7 years without demands. Today's retention period should be extended from 2 years to 6 years.

It is cost beneficial to retain MIC 2 items for up to 72 months without demands (extend current retention period from 2 years to 5 years). Retaining items more than 72 months results in retention costs exceeding repurchase costs by $22K.

Table 6 reiterates that it is not cost beneficial to retain MIC 3 and 4 items for more than 3 years between demands. So we calculated the benefits of retaining MIC 3 and 4 items for up to 3 years. Table 7 shows the number of MIC 3 and 4 items with demands 25 to 30 months apart and 31 to 36 months apart and the related delta. The data are relative to each time period, not cumulative.

MIC	Number of Items	Number of Items with Subsequent Demands	Estimated RPC	Estimated RC	Amount RPC Exceeded RC (Delta)
1	52,180	13,038	$1.559M	$.736M	$.823M
2	80,234	14,076	$.833M	$.617M	$.216M
3	30,548	3,125	$.077M	$.077M	$.0
4	29,448	2,119	$.074M	$.113M	($.039M)
Total	192,410	32,358	$2.543M	$1.543M	$.999M

Table 4. Subsequent Demands by MIC

	MIC 1		MIC 2		MIC 3		MIC 4	
Months Between Demands	Items with Subseq Demands	RPC-RC Delta	Items with Subseq Demands	RPC-RC Delta	Items with Subseq Demands	RPC-RC Delta	Items with Subseq Demands	RPC-RC Delta
37-48	5,046	$471K	5,414	$95K	1,092	$1.0K	933	($21K)
49-60	8,092	$761K	8,504	$227K	1,753	$1.0K	1,442	($17K)
61-72	10,018	$836K	10,568	$259K	2,223	$.5K	1,686	($19K)
73-84	11,227	$837K	11,905	$237K	2,507	$2.0K	1,850	($28K)
85-96	11,986	$792K	12,862	$205K	2,744	($2.0K)	1,956	($36K)

Table 5. Cumulative Number of Items with Subsequent Demands and Related Delta

	MIC 1	MIC 1	MIC 2	MIC 2	MIC 3	MIC 3	MIC 4	MIC 4
Months between Demands	Items with Subseq Demands	RPC-RC Delta	Items with Subseq Demands	RPC-RC Delta	Items with Subseq Demands	RPC-RC Delta	Items with Subseq Demands	RPC-RC Delta
37-48	5,046	$471K	5,414	$95K	1,092	$1K	933	($21K)
49-60	3,046	$289K	3,090	$131K	661	($.1K)	509	$4K
61-72	1,926	$75K	2,064	$32K	480	($.4K)	244	($2K)
73-84	1,209	$1K	1,337	($22K)	274	$1K	164	($9K)
85-96	759	($45K)	957	($32K)	237	($3K)	106	($8K)

Table 6. Number of Items with Subsequent Demands and Related Delta

	MIC 3		MIC 4		Totals	
Months between Demands	Items with Subseq Demands	RPC-RC Delta	Items with Subseq Demands	RPC-RC Delta	Items with Subseq Demands	RPC-RC Delta
25-30	2,485	$64K	2,731	$121K	5,216	$185K
31-36	505	($18K)	408	($31K)	913	($49K)

Table 7. MIC 3 and 4 Items with Subsequent Demands in 25-to-30 and 31-to-36 Month Periods

The number of MIC 3 and 4 items with demands between 25 to 30 months apart was almost six times more than the number with demands in the 31-to-36 month period. As expected, the repurchase costs for items in the 25-to-30 month period exceeded retention costs by $185K ($64K+$121K) while the retention costs for items in the 31-to-36 month period exceeded repurchase costs by $49K. So retaining MIC 3 and 4 items for at least 30 months between demands would have prevented $185K in repurchase costs and reduced the number of cause code A and B due-outs by 5,216 at our six sample bases over a period of 12 years. In short, it is economical to retain MIC 3 and 4 items for 30 months without demands—extending their current retention period from 12 to 24 months.

In earlier studies, AFLMA found it was more efficient to divide retention policies by unit price and expendability, recoverability, or reparability code. Analysis revealed whether MIC 1 and 2 low-cost items should be retained longer than high-cost items. Since the cost to retain items is based on the unit price, it stands to reason if the high-priced items were not being demanded beyond the retention period (therefore, not increasing repurchase costs), then it would be wise not to retain them. Table 8 shows the number of MIC 1 and 2 items with subsequent demands and related repurchase costs based on a 7-year retention period for MIC 1 items and a 6-year retention period for MIC 2 items.

	UP<$750	UP=>$750	Total
MIC	Items with Subsequent Demands/Inventory Dollar Value	Items with Subsequent Demands/Inventory Dollar Value	Items with Subsequent Demands/Inventory Dollar Value
1	10,855/$1.0M	391/$.7M	11,246/$1.7M
2	10,448/$0.6M	142/$.1M	10,590/$0.7M
Total	21,303/$1.6M	533/$.8M	21,836/$2.4M

Table 8. Number of MIC 1 and 2 Items with Subsequent Demands and Their Related Inventory Dollar Value, Stratified by Unit Price

	UP<$750	UP=>$750	Total
MIC	Number of Items w/o Subsequent Demands/Inventory Dollar Value	Number of Items w/o Subsequent Demands/Inventory Dollar Value	Number of Items w/o Subsequent Demands/Inventory Dollar Value
1	38,715/$5.4M	1,713/$4.6M	40,428/$10.0M
2	65,862/$5.9M	1,427/$2.5M	67,289/$8.4M
Total	104,577/$11.3M	3,140/$7.1M	107,717/$18.4M

Table 9. Number of MIC 1 and 2 Items without Subsequent Demands and Their Related Inventory Dollar Value

Table 8 shows that 97 percent (10,855/11246) of MIC 1 items with demands in a 3- to 7-year period had a unit price less than $750. Ninety-nine percent demands in a 3- to 6-year period had a unit price less than $750. By using a $750 unit price cap, 98 percent (21,303/21,836) of the items with subsequent demands were retained. Table 9 shows the number of MIC 1 and 2 items that *did not* have demands and their related inventory dollar value.

Ninety-seven percent (104,577/107,717) of the items with no subsequent demands have a unit price less than $750. However, these items only account for 63 percent ($11.3M/$18.4M) of the total inventory dollar value of all items with no subsequent demands. Therefore, retention costs can be reduced 37 percent by retaining only MIC 1 and 2 items with a unit price less than $750.

However, Table 8 shows 533 items (391 are MIC 1) would be disposed of if all MIC 1 and 2 items with a unit price equal to or greater than $750 are not retained. In an effort to retain these items, the timing of their demands was considered. The majority of subsequent demands for these items occurred 3 to 5 years after the last demand. Table 10 shows the timing of subsequent demands, number of items with subsequent demands during that time, the repurchase costs, the retention costs, and their delta (repurchase costs–retention costs). The results are listed by MIC.

Table 10 shows that by retaining MIC 1 items with an UP=>$750 for at least 5 years between demands (2 years more than current policy) an additional 288 items with a repurchase cost of $.5M would be available. The downside to placing a retention cap of 5 years on these items is that 103 (391 – 288) items would experience demands after being disposed. The upside is avoiding retention costs of more than $.2M for items whose total repurchase costs over the remaining 3 years totaled a little more than $.1M. It is not cost effective to extend the retention period for MIC 2 items with a UP=>$750. As Table 10 illustrates, the repurchase costs for those items exceeded retention costs by $.03M when the retention period was extended 1 year and by $.02M when extended by 2 years.

The data in Tables 4 through 10 show that it is beneficial, from a financial perspective and a mission support perspective, to extend the retail retention policy. Our recommended policy changes and their potential annual benefits throughout the

Air Force are described below and listed in Table 11.

Retain MIC 1 items < $750 at least 72 months after SARSD.

Result: MICAP/AWP incidents reduced by 12,040 per year. We arrived at 12,080 by determining average MICAP reductions per base at the six bases [10,836/6=1,806] for the 12 years. Then we determined the per base annual reduction total [1,806/12=150.5]. To get the total Air Force annual reduction, we multiplied by 80 bases [150.5*80=12,040]. Estimated repurchase cost avoidance comes to $1.8M ($1.6M/6/12*80).

Retain MIC 2 items with a unit price < $750 at least 60 months after SARSD.

Result: High-priority back orders reduced by 11,584 (10,426/6/12*80). Repurchase cost avoidance equals $2.5M ($2.3M/6/12*80).

Retain MIC 1 with a unit price = >$750 at least 48 months after SARSD.

Result: MICAP and AWP back orders reduced by 320 (288/6/12*80) each year. Repurchase cost avoidance equals $.6M ($.5M/6/12*80).

Retain MIC 3 and 4 items at least 24 months after SARSD.

Result: Air Force-wide urgency need designator B and C due-outs reduced by 5,795 (2485+2731=5216/6/12*80) each year. Repurchase cost avoidance equals $.2M ($64K+$121K=$185K/6/12*80).

Changing retention periods using the rules described improves mission performance (prevents approximately 29,739 cause code A and B back orders) and is cost beneficial (achieves repurchase cost avoidance of $5.1M annually).

Negative Impacts of Longer Retail Retention Periods to DLA. Extending retail retention periods would result in even more infrequent demand patterns to DLA. Analysis of base-level data shows demands for some items can be as much as 5 years (DLA's retention period) apart. From 1988 to 2000, more than 1,000 items at Langley AFB had demands more than 5 years apart. During the same time period, more than 2,000 items at Dover AFB had demands more than 5 years apart. If bases retain stock that long, DLA will not see demands (requisitions) and will be inclined to dispose of central stocks for items that are still active; that is, still experiencing demands.

There may be some benefit to making centralized retention and disposal decisions on these infrequently demanded items rather than each echelon's making independent decisions. Today, DLA only is aware of demands as requisitions. However, some items may be demanded and then satisfied from existing retail stocks without generating a requisition to DLA. So DLA is unaware of these demands and may choose to dispose of stock prematurely. Therefore, extending retention periods might result in DLA's losing visibility of retail demands on some items. The loss of demand visibility could result in premature disposal of wholesale or retail stock and/or incorrect demand forecasting. Proposed actions to resolve this potential negative impact are addressed in the next section.

Improving Air Force Interface with DLA to Ensure Retail and Wholesale Stocks Are Effectively and Efficiently Retained. Air Force bases should provide asset, demand, and weapon systems data to DLA so DLA can make more informed retention and disposal decisions. One method of providing the necessary information to DLA is by modifying and using the existing asset visibility status report process (DZE/DZF).

Before disposing of wholesale stocks, DLA centers could send an asset visibility status report request (DZE) to all registered Air Force users. DLA item managers could review responses (DZF) to determine an item's worldwide asset position and demand histories. If the item shows no activity, DLA should proceed with disposal. However, if the item shows activity, DLA could develop business rules

	MIC 1	MIC 1	MIC 1	MIC 1	MIC 2	MIC 2	MIC 2	MIC 2
Months Between Demands	Items with Subseq Demands	RPC	RC	RPC-RC Delta	Items with Subseq Demands	RPC	RC	RPC-RC Delta
37-48	189	$.3M	$.1M	$.2M	63	$.05M	$.08M	($.03M)
49-60	288	$.5M	$.2M	$.3M	97	$.08M	$.1M	($.02M)

Table 10. Subsequent Demands for MIC 1 and 2 Items with a Unit Price =>$750

MIC	New Retention Period	Unit Price	Number of Reduced Cause Code A & B Due-Outs (Annually)	Repurchase Cost Avoidance
1	72 Months	<$750	12,040	$1.8M
1	48 Months	=>$750	320	$.6M
2	60 Months	<$750	11,584	$2.5M
3 & 4	24 Months	No Edit	5,795	$.2M
Totals			29,739	$5.1M

Table 11. Summary of Annual Due-out Reductions and Repurchase Cost Avoidance throughout the Air Force

based on knowledge of the likelihood of future usage and disposition. The base could also include the mission impact code (a measure of item essentiality) and weapon system identification (standard reporting designator) if applicable. The demand data could be used to make retention decisions and establish retention levels. Essentially, DLA would use base demand data, instead of requisition demand data, with DLA's current retention policy for these infrequently demanded items.

This same step could be added to the process used to provide disposition instructions to retail supply accounts. When DLA centers receive a request for disposition instructions from a retail supply account for an item with the infrequent demand characteristics described earlier, they could send a request for an asset visibility status report to all Air Force users. DLA may decide that a base should retain items longer in the event of a future need at some other base, or it could direct the return of assets to DLA to retain for worldwide use.

Today, when the SBSS receives a DZE, the SBSS response (DZF) includes an item's serviceable balance, due-in balance, and requisition objective. This information provides an item's asset position for the wholesale activity. The response does not include historical demand data or the serviceable balance of assets located in organizational bench stocks or shop stocks kept by maintenance personnel. Occasionally, demands on the SBSS to replenish bench-stock and shop-stock levels are infrequent, and/or the quantity involved is not large enough to reduce the SBSS stock level to the point that a demand (requisition) is placed from the SBSS to the applicable DLA center. In these cases, the item's usage is recorded on the item record detail but is *hidden* from DLA. By modifying the DZF, this information could be captured and relayed to DLA.

Each SBSS item record detail contains up to 18 months of demand history. The DZF could be modified to provide the number of units demanded during an 18-month period, date of last demand, information on mission impact, and type of weapon system. By reviewing this historical demand and mission-related information, DLA could better assess an item's potential future usage and mission impact.

The amount of demand data maintained on the item record detail is a limiting factor to modifying and using the DZF to report demand data to DLA as needed. As mentioned previously, there are only 18 months of demand data available. Therefore, if item managers do not have reason to review the retail demand history of items with demands more than 18 months apart, some of the demand history will be lost. So the process will be hit or miss unless bases report demand data on all budget code 9 items via DZF on a recurring basis and DLA archives the data. The recurring basis should be semiannually, since each item record's demand data are updated every 6 months.

Modifying the DZF transactions to include demand histories, standard reporting designators, and mission impact codes is a short-term improvement effort with minor modifications required to the SBSS and DLA systems. An alternative short-term action to modifying DLA systems is to allow the Defense Automated Addressing System to receive and archive DZF transactions for DLA. DLA item managers could then access necessary information as required via the Internet or other vehicle.

A long-term improvement effort should be established to develop a new transaction to consolidate and report demand and mission-related information on budget code 9 items to item managers. The DZE/DZF process will be fine in the near term, but plans should be developed for a smoother and more reliable process. Benefits of such an effort include providing DLA data necessary to determine retention quantities, identify cycles in demands, and more accurately relate assets to weapon systems.

Today, DLA centers are making disposition decisions without the benefit of all relevant information. Specifically, *hidden* demands that indicate future requirements are not currently visible. Requesting, receiving, and reviewing weapon system and demand data on items prior to making disposition decisions will prevent disposing of weapon system support items whose usage is hidden from the current disposal decision process.

For the short-term, the Air Force should modify the DZF transaction to report budget code 9 item demands, mission essentiality, and weapon system application data to wholesale activities. As a long-term improvement effort, the Air Force should work with DLA to analyze the possibility of creating a new transaction to report budget code 9 demand data, mission-related data, and any other data that would provide item managers all relevant information on which to base retention and forecasting decisions. Air Force and DLA managers should explore the various possibilities that the additional data can provide. For example, wholesale retention decisions, weapons system coding, and worldwide retention decisions are all possible applications for demand and mission data.

Summary

Lengthening retention times for select budget code 9 items has the potential to have the following Air Force-wide impact on an annual basis.

- Decrease cause code A and B due-outs by approximately 30,000.
- Decrease MICAP/AWP incidents by approximately 12,000.
- Prevent premature disposal of approximately 30,000 items.
- Prevent approximately $5.1M in repurchase costs.

Longer retention timeframes might lead to premature disposal of wholesale or retail stock and/or incorrect demand forecasting and insufficient procurement actions. Therefore, the Air Force needs to improve its interface with DLA to report demands and weapon systems application for consumable items.

Recommendations

- Modify current retention rules on budget code 9 items with expendability, recoverability, reparability code equal to XB(x) or XF(x), issue exception code not equal to 8 or 9, and source of supply equal to S(XX), A(XX), B(XX), or N(XX) as follows. For XB3 Items:
  - ♦ Extend retention period for MIC 1 items with a unit price <$750 to 72 months after SARSD.
  - ♦ Extend retention period for MIC 2 items with a unit price <$750 to 60 months after SARSD.
  - ♦ Extend retention period for MIC 1 items with a unit price =>$750 to 48 months after SARSD.
  - ♦ Extend retention period for MIC 3 and 4 items to 24 months after SARSD.

  For XF3 Items:
  - ♦ Extend retention period for MIC 1 items with a unit price <$750 to 84 months from the date of last demand.
  - ♦ Extend retention period for MIC 2 items with a unit price < $750 to 72 months from the date of last demand.
  - ♦ Extend retention period for MIC 1 items with a unit price => $750 to 60 months from the date of last demand.
  - ♦ Extend retention period for MIC 3 and 4 items to 36 months from the date of last demand.
- In the short term, work with DLA and DoD to approve modification of the DZF transaction to report consumable item demands and weapon systems application data to wholesale activities.
- Task AFLMA to work with DLA to analyze potential applications of the weapon system detail for base retention, weapon system coding, and forecasting decisions.

Implementation

The results of the analysis, which included two proposals, were presented to the Air Force Supply Executive Board in October 2000. Proposal 1 was to extend the retention period based on economics (balance the cost to retain against the benefit of prevented repurchase cost). Proposal 2 was an extension of proposal 1 in that it retained, for the life of the weapon system, all items applicable to a weapon system. Proposal 2 showed the impact of retaining all items per proposal 1, plus retaining weapon system items for the life of the weapon system.

To decide the benefits of proposal 2, we counted the additional demands for MIC 1 and 2 items (weapon system items) after our proposed economic retention period. That is, how many demands occurred after our proposed retention period and would, therefore, provide additional benefit. Table 12 shows the number of subsequent demands for MIC 1 and 2 items.

While our analysis revealed most benefits were realized in the early years and, therefore, made the later years *appear* cost effective, the trend line in Figure 1 indicates it is cost effective overall to retain budget code 9 items for more than 8 years between demands. Plus, retaining items for the length of the weapon-system life prevented back orders and repurchase actions. As a result, the AFSEB approved extending the retail retention period for DLA and other service-managed XB and XF items by retaining weapon systems support items until the applicable weapon system is deactivated.

The AFSEB's action complies with DoD guidance. DoD 4140.1R provides each Service the latitude to establish unique retail retention periods for items reported as excess that are not authorized return by wholesale item managers.

The AFSEB decision is based upon the intent of DoD 4140.1R; that being, economic retention levels should be based on an economic analysis comparing retention costs to disposal costs. The economic analysis should consider the costs of retaining item stocks; potential long-term demands for an item; potential repurchase costs; and for weapons system support items, the expected life of the system and the number of systems in use.

So the Air Force is to retain weapon system items for the life of the weapon system. Listed below are the proposed plans to implement this policy Air Force-wide.

- Develop a surge program to identify and load life-of-systems-stock (LSS) adjusted stock levels (ASL) on weapons system-related items at each base. Since these ASLs identify items applicable to weapons systems, future references to these LSS ASLs will be simply weapon systems details (WSD). The surge program first identities valid standard reporting designators (SRD). The program will use the SRD (008) record as the starting point to decide which items on which SRDs get WSD records. An SRD record (008 record)

MIC	Items with Subsequent Demands after Proposed Retention Period	Estimated RPC After Proposed Retention Period	Estimated RC after Proposed Retention Period			RPC-RC Delta
			Disposal Revenue	*Storage Costs*	Total Retention	
1	1,811	$114K	*$213K*	*$136K*	$349K	($235K)
2	3,508	$131K	*$184K*	*$205K*	$389K	($258K)
Total	5,319	$245K	*$397K*	*$341K*	$738K	($493K)

Table 12. Subsequent Demands Beyond Our Proposed Economic Retention Period

is distinct from the SRD consumption record. The SRD record identifies by SRD, and the SRD consumption record is by national stock number (NSN). The base must ensure its SRD records are accurate and correctly reflect MICAP reportable SRDs. The surge program will scan the 008 records and identify all SRDs that are MICAP reportable (MICAP flag = Y). The base will have the ability to add any valid SRDs by creating an SRD record. With the complete list of SRDs, the surge program will prepare WSD-load images for all NSNs with a bench-stock master detail record (with the designated SRD), any NSN with an SRD consumption record for the selected SRDs, or any NSN with a readiness spares package or high-priority mission support kit (including contingency high-priority mission support kit) detail. So any item on a bench-stock or additive kit for that SRD, plus any item with recent consumption citing that MICAP reportable SRD, will have a WSD. The WSD will ensure all on-hand balances for items with any record of consumption on those SRDs will not be disposed of. The WSD will list the SRD and also be standardized to identify it as a retention policy WSD. The proposed format for the 1F3 to load the WSD includes RET (for retention) in columns 78-80, M671 (for manual 67-1 per current AFM 23-110 direction) in fields 44-47, and the SRD in fields 58-60. We start with SRDs with an SRD record and MICAP flag of Y to ensure WSDs are applied to only *valid SRDs*.

- Run the surge program and load the WSD details. Each base will run the surge program quarterly to load WSDs on any new NSN (one added to a bench stock or a new SRD consumption record). Also, any item with a WSD and an SRD not on an SRD (008) record will be identified.

The surge program will create a WSD delete image that the base can input after review. This deletes WSD levels on a weapon system that is no longer active (no longer has an SRD record at the base).

We tested the SBSS WSD code to ensure it prevents disposal but does not prevent excess reporting, returns, and redistribution. The test showed that a WSD detail does what we want—it will prevent disposal but not prevent excess reporting, return (it will ship down to the requisitioning objective), or redistribution. In addition, the SBSS will delete the item record if there is no on-hand balance but there is a WSD. Different quantities were tested in the WSD detail. The quantity must be positive, but it does not have to meet or exceed the on-hand balance to prevent disposal of any quantity of the NSN. So a WSD prevents disposal of any amount for that NSN.

The AFSEB has implemented the surge program to create the WSD but not yet decided to implement the extended economic retention rules. The Air Force will not realize the full benefits in terms of 12,000 annual MICAP reductions and $5.1M annual savings unless it implements the extended economic retention rules.

It is important to understand that many of the items that the AFSEB wants to retain will not have a demand and, therefore, no WSD. Failure to extend the retention period for these items will mean the items will be disposed of according to current retention rules. To prevent that, a surge program should be developed to extend retention periods for items without a WSD based on the following rules.

For XB3 items without a WSD, extend retention periods as follows:

- MIC 1, UP < $750 to 72 month after SARSD
- MIC 2, UP < $750 to 60 months after SARSD
- MIC 1, UP => $750 to 48 months after SARSD
- MIC 3 and 4 items to 24 months after SARSD

For XF3 items without a WSD, extend retention periods as follows:

- MIC 1, UP< $750 to 84 months from the date of last demand
- MIC 2, UP< $750 to 72 months from the date of last demand
- MIC 1, UP=> $750 to 60 months from the date of last demand
- MIC 3 and 4 items to 24 months from the date of last demand

These rules will ensure items not weapon-system coded (either because they are nonweapon system or are just not coded as weapon-system items) are retained at least as long as economically beneficial.

Additional Considerations

An additional benefit to establishing WSDs is their potential interface with the DLA Weapon Systems Support Program (WSSP). Once the WSDs are created, the SBSS will have the mission impact code and weapon system application data for all weapon system items. This is the data the Air Force inputs to DLA's WSSP. The current system used to pass data to DLA's WSSP is convoluted—base-level MICAP reports (generated from SBSS requisitions) are sent to AFMC. AFMC then reformats the MICAP data for input to DLA. The WSD provides a method to feed weapon system data for all items—not just items that generate MICAP requisitions—directly to DLA. Plus, the data are permanently on file at the base for reconciliation as required.

A real knowledge of supply and movement factors must be the basis of every leader's plan; only then can he know how and when to take risks with those factors, and battles are won only by taking risks.

—Field Marshal A. C. P. Wavel, Royal Army

If support personnel, from flight surgeons to mechanics, are effectively told their services are needed only if they cost out at less than the private sector equivalents, is it realistic to expect they will place service before self in assessing the loyalty they owe the DoD?

—Colonel R. Philip Deavel, USAF

Thinking About Logistics

Surely one of the strangest things in military history is the almost complete silence upon the problem of supply.

—*The Lifeblood of War*

Understanding the elements of military power requires more than a passing knowledge of logistics and how it influences and, in many cases, dictates strategy and tactics. *An understanding of logistics comes principally from the study of history and the lessons that history offers.* Unfortunately, despite its undeniable importance, surprisingly little emphasis is placed on the study of history among logisticians and the lessons to be found and studied. To compound matters, the literature of warfare is replete with triumphs and tragedy, strategy and tactics, and brilliance or blunders; however, far less has been written concerning logistics and the tasks involved in supplying war or military operations.[1]

General Mathew B. Ridgeway once observed, "What throws you in combat is rarely the fact that your tactical scheme was wrong . . . but that you failed to think through the hard cold facts of logistics." The general's message is important—logistics is the key element in warfare, more so in the 21st century than ever before. Without question, success on the modern battlefield is dictated by how well the commander manages available logistical support. The victories by the United States in three major wars (and several minor wars or conflicts) since the turn of the century are far more directly linked to the ability to mobilize and bring to bear economic and industrial power than any particular level of strategic or tactical design. The Gulf War further illustrates this point.

> As the machinery of the Allied Coalition began to turn, armchair warriors addicted to action, and even some of the hastily recruited military experts, revealed a certain morbid impatience for the "real war" to begin. But long before the Allied offensive could start, professional logisticians had to gather and transport men and materiel and provide for the sustained flow of supplies and equipment that throughout history has made possible the conduct of war. Commanders and their staffs inventoried their stocks, essayed the kind and quantities of equipment and supplies required for operations in the severe desert climate, and coordinated their movement plans with national and international logistics networks. *The first victory in the Persian Gulf War was getting the forces there and making certain they had what they required to fight* [Emphasis added]. Then and only then, would commanders initiate offensive operations.[2]

From a historical perspective, ten major themes stand out in modern US military logistics.

- The tendency to neglect logistics in peacetime and to expand hastily to respond to military situations or conflict.
- The increasing importance of logistics in terms of strategy and tactics. Since the turn of the century logistical considerations have increasingly dominated both the formulation and execution of strategy and tactics.
- The growth in both complexity and scale of logistics in the 20th century. Rapid advances in technology and the speed and lethality associated with modern warfare have increased both the complexity and scale of logistics support.
- The need for cooperative logistics to support allied or coalition warfare. Virtually every war involving US forces since World War I has involved providing or, in some cases, receiving logistics support from allies or coalition partners. In peacetime, there has been an increasing reliance on host nation support and burden sharing.
- Increasing specialization in logistics. The demands of modern warfare have driven an increasing level of specialization among support forces.
- The growing tooth-to-tail ratio and logistics footprint issues associated with modern warfare. Modern, complex, mechanized, and technologically sophisticated military forces capable of operating in every conceivable worldwide environment require that a significant portion, if not the majority of it, be dedicated to providing logistics support to a relatively small operational component. At odds with this is the need to reduce the logistics footprint in order to achieve the rapid project of military power.
- The increasing number of civilians needed to provide adequate logistics support to military forces. Two subthemes dominate this area: first, unlike the first half of the 20th century, less reliance on the use of uniformed military logistics personnel and, second, the increasing importance of civilians in senior management positions.
- The centralization of logistics planning functions and a parallel effort to increase efficiency by organizing along functional rather than commodity lines.
- The application of civilian business processes and just-in-time delivery principles, coupled with the elimination of large stocks of spares.
- Competitive sourcing and privatization initiatives that replace traditional military logistics support with support from the private business sector.

In 1904, Secretary of War Elihu Root warned, "Our trouble will never be in raising soldiers. Our trouble will always be the limit of possibility in transporting, clothing, arming, feeding, and caring for our soldiers . . . ."[3] Unfortunately, the historical tendency of both the political and military leadership to neglect logistics activities in peacetime and expand and improve them hastily once conflict has broken out may not be so possible in the future as it has in the past. A declining industrial base, flat or declining defense budgets, force drawdowns, and base closures have all contributed to eliminating or restricting the infrastructure that made rapid expansion possible. Regardless, modern warfare demands huge quantities of fuel, ammunition, food, clothing, and equipment. All these commodities must be produced, purchased, transported, and distributed to military forces. And of course, the means to do this must be sustained. Arguably, logistics of the 21st century will remain, in the words of one irreverent World War II supply officer, "The stuff that if you don't have enough of, the war will not be won as soon as."[4]

Notes

1. John A. Lynn, ed, *Feeding Mars: Logistics in Western Warfare from the Middle Ages to the Present,* San Francisco: Westview Press, 1993, vii.
2. Charles R. Shrader, *U.S. Military Logistics, 1607-1991, A Research Guide*, New York: Greenwood Press, 1992, 3.
3. Shrader, 9.
4. Julian Thompson, *The Lifeblood of War: Logistics in Armed Conflict*, Oxford: Brassy's, 1991, 3.

AIR FORCE SUPPLY:

The Air Force needs a complete set of aggregate, macro, or strategic-level metrics that assess the overall health of supply, relative to weapon system availability

Background

Presently, strategic-level metrics do not assess the overall health of Air Force supply, relative to weapon system availability. Because of this, the Air Force Logistics Management Agency (AFLMA) was asked to develop a robust, yet small, set of performance measures or metrics, at the aggregate level, that represents the health of supply or the integrated supply chain. Based on guidance from senior Air Force leadership, the analysis answered the following.

- What are the metrics?
- Who should collect performance measurement data?
- How often the data should be collected?
- How the data should be collected?
- Who should analyze the data?
- Who is the ultimate reviewer of the metric?

Discussion

The overriding objective of the Department of Defense (DoD) logistics system is to provide responsive and cost-effective support to ensure readiness and sustainability for the total force in peacetime and war.[1]

Measures, Metrics, and Health

An essential ingredient to the success of DoD, as well as the Air Force logistics system, is the effective and efficient management of the supply system or supply chain. Supply chain performance will either positively or negatively affect 85 percent of an organization's costs, so a healthy supply chain is essential.[2]

A survey was conducted to determine what metrics were presently in use. The results found a large number of measurements for everything, from customer satisfaction to warehouse/inventory management to weapon system support. However, it soon became evident that even with the abundance of metrics already available, there were few, if any, that could or should be singled out as the metrics that indicate the *health* of Air Force supply. Even if a handful of metrics from the population available could be selected, it would be very difficult to link them to underlying processes and activities that drive supply and supply chain performance. The case can easily be made that any metric scrutinized by senior leaders should be directly linked to the more detailed metrics used by low- and mid-level managers to diagnose and correct problems. Leadership at all levels should be able to drill down through mid- to low-level metrics to ascertain what is driving declining performance and, therefore, what needs to be changed to increase or improve performance. Most of the detailed metrics that are readily available fail to measure performance from a macro or global aggregate viewpoint. In order to develop meaningful metrics, the fundamental processes involved in the Air Force supply system need to be modeled.

Design Experiment

To create a model and then derive key metrics, the processes involved need to be examined in stages. To do this, the model began as a simple listing that outlined key supply system processes. Several experimental design concepts, as part of a design experiment, were then used to further develop and refine the model. Conceptually, a design experiment is a test in which changes are made to system input or process. The resulting output is then examined in order to determine causal factors and possible explanations. The emphasis is not on the test but on the development of the model. In this analysis, changes to the input were real-world budgetary constraints. The output was, of course, weapon system availability. However, the analysis recognized that budgetary changes are not the sole determinant of availability. There are other influencing factors, both controllable and uncontrollable, that can detract from or enable supply system performance.

By employing the balanced scorecard technique, the model was converted to something more useful in an organizational sense. However, the traditional four-node setup was not used. Rather, it was converted to reflect the nodes or segments created in the supply model, which is more salient and reflective of the supply chain structure. In the sections that follow, each phase of model development, the thought processes involved, and the results of each phase will be examined in more detail. This discussion forms the basis for the end result of the analysis—a set of useful aggregate metrics that focuses on the health of Air Force supply. Also included in the discussion are examples of other models and concepts that mirror and provide evidence that the type of model developed, as well as the concepts associated with it, are solid in foundation.

Model Development

How do you focus on organizational health? As Juran, Deming, and others who have studied the question would agree, the most important aspect in developing performance measures is the definition of the processes being measured. The definition needs to be simple, unambiguous, and without adding unnecessary complexity, all encompassing. The supply chain can be represented simply as a cycle containing the following elements: budget, requirements determination, level determination, buy, repair, and asset movement. The relationship among the elements is not linear, so there is no particular sequence for the supply process. Rather, these elements are supply core processes that, together with the enablers, define the supply chain. To be effective and not just a collection of defined processes, however, the supply chain must be enabled. In terms of the Air Force, these enablers are information, personnel, organizational structure, funding—also an input to the Air Force supply chain—and policies. The result or output of all these processes and enablers is weapon system availability (Table 1).

The quick, uncorrupted flow of information is critical in each phase of supply. In addition to the efficient and effective flow of information, a factor that touches each phase of the supply system or chain in varying degrees is personnel. No matter how far the military advances in automation,

AFLMA Analysis

Captain Wesley E. Manship, Jr

Aircraft Availability (War and Peace)	
Core Processes	**Enablers**
Repair	System Effectiveness
Buy	Manning Effectiveness
Stockage/Distribution	Cash Flow (Fund Collection) Effectiveness
Funding	
• Requirement	
• Budget	
• Execution	

Table 1. Supply Model Output

invariably the Air Force, as well as the other Services, will be people centric, or to phrase it another way, our business will always be people. Organizational structure streamlines and consolidates responsibilities and clarifies lines of command, thereby putting responsibility, authority, and capability together.[1] Policy is by far the most encompassing enabler, governing other enablers and core processes.

An example of and confirmation of this particular type of structure is Air Force Materiel Command (AFMC) adherence to the *Supply Chain Management Master Program Plan* (Figure 1).

Of course, some of the terms are different, but the focus is entirely the same. Process plus strategy equals policy, people equal personnel, technology equals information management, and infrastructure is visible in organizational structure. Also discussed in the AFMC plan are the following supply chain management concepts: velocity, variability, and visibility (Figure 2).

Essentially, these concepts express the value of information flow and are represented in the AFLMA-developed supply model by the enabler, information management.

The Logistics Management Institute (LMI) used a similar structure in the Supply Chain Operations Reference model in a June 1999 study, *Supply Chain Management: A Recommended Performance Measurement Scorecard*. The study emphasized four functional areas of the supply chain: plan, source, maintain, and deliver. While this is a solid structure that encompasses supply chain core processes, the measurement pertaining to the enablers of the supply chain will be secondhand as a result of metrics reflecting the relative success, or lack thereof, of a core process.

To recap briefly, the core processes and enablers comprise the supply chain, which, in the most basic sense, is the system that is being modeled. The system receives input that will undergo some form of transformation and generate an output. In this analysis, changes to the input were real-world budgetary constraints. Weapon system availability is the end output. There are other factors that affect the supply chain or system, which were referred to earlier as influencing factors. They can be either controllable or uncontrollable. (Controllable factors are our enablers. For example, we can effect a change in policy that will combat civilian work stoppage.) The environment in which the supply system exists will influence it in a variety of negative and positive ways. Uncontrollable influences include:

- Unpredicted failures, both in aircraft and ground equipment
- Real-world interruptions such as weather or political influence

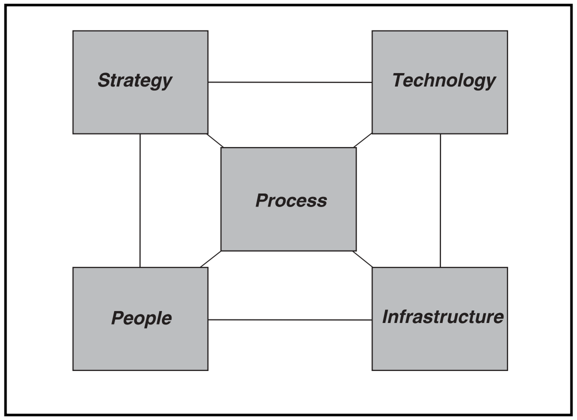


Figure 1. Supply Chain Model

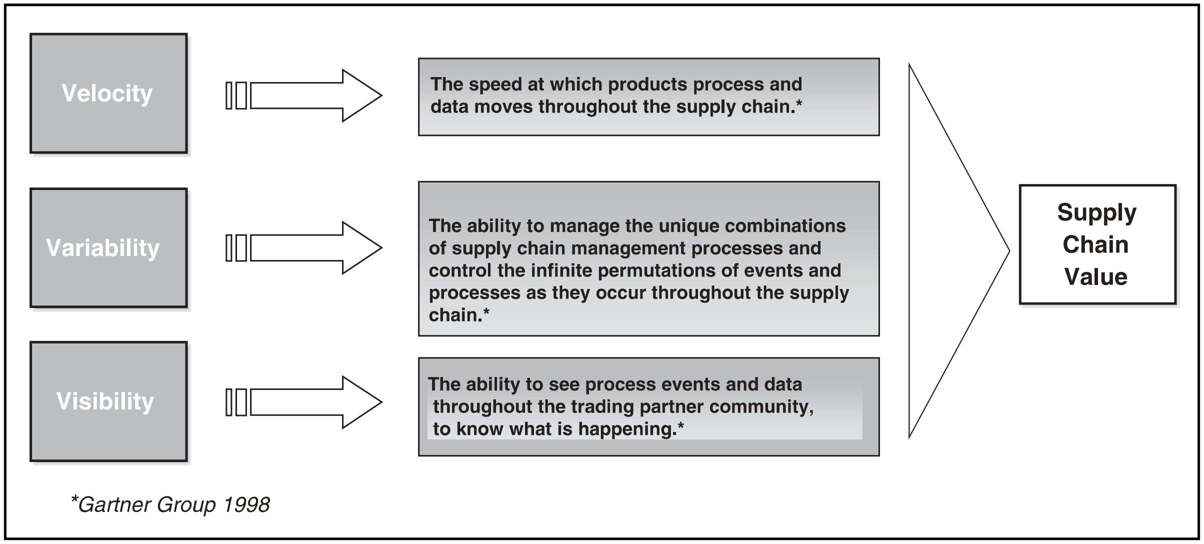


Figure 2. Supply Chain Concepts

- Contingencies or an unpredicted increase in operating tempo (OPTEMPO)
- Civilian sector work stoppage such as Federal Express/United Parcel Service strikes

Once the model was developed and its structure and underlying concepts validated, the question became how to determine or create meaningful metrics from the segments of this model. Obviously, the initial focus should be on budget requirements, requirements determination, level determination, buy, repair, and move—the core processes and phases of the Air Force supply system. Recognizing that Air Force supply presently consists of retail and wholesale portions (segments), a two-dimensional matrix can be formed that accounts for both while interrelating them (phases and segments within the matrix) (Figure 3). For example, in the matrix, the cross of buy and wholesale will yield a number of performance measures. The same logic applies for each phase and segment, yielding aggregate measures for each phase crossed with each segment.

	Wholesale	Retail
BUDGET Determination	****	****
REQUIREMENT Determination	****	****
LEVEL Determination	****	****
BUY	****	****
REPAIR	****	****
MOVE	****	****

**** Aggregate performance measures or metrics

Figure 3. Supply Segments

These measures should represent the overall health of supply.

The best way to define performance of any system is to compare expected performance to actual performance, establishing a ratio or percentage, thereby providing an indicator of the health of the system. Incorporating expected versus actual results in a three-dimensional matrix containing the source or supply phase (budget, requirements determination, level determination, buy, repair, and move), segment of supply (wholesale and retail), performance metrics, and the measure or percentage of the indicator (Figures 4).

What remained was consideration or integration of the five enablers— information management (data and system integrity), personnel, organizational structure, funding (also input into the model), and policies—previously defined. While none of the enablers are core supply processes, each has tremendous influence on establishing and sustaining the supply chain.

Transforming the Model—Balanced Scorecard Approach

Within industry, both researchers and managers have tried to develop adequate performance measures by using weighted financial and operational measures (one would be weighted heavier than the other). For example, correcting poor cycle time or high failure rates will provide greater financial results. The tradeoffs and potential for some level of suboptimization in the weighting process in this example are evident. However, in terms of the Air Force, in order to avoid suboptimizing any segment of the supply system, financial and operational measures must be used in order to focus attention on critical areas. Recently, to focus on critical business areas, LMI, AFMC, and the Air Force Logistics Transformation Team adopted a balanced scorecard approach. This approach is represented in the *Supply Chain Management Master Program Plan*, developed by the AFMC Director of Logistics, and *Supply Chain Management: A Recommended Performance*

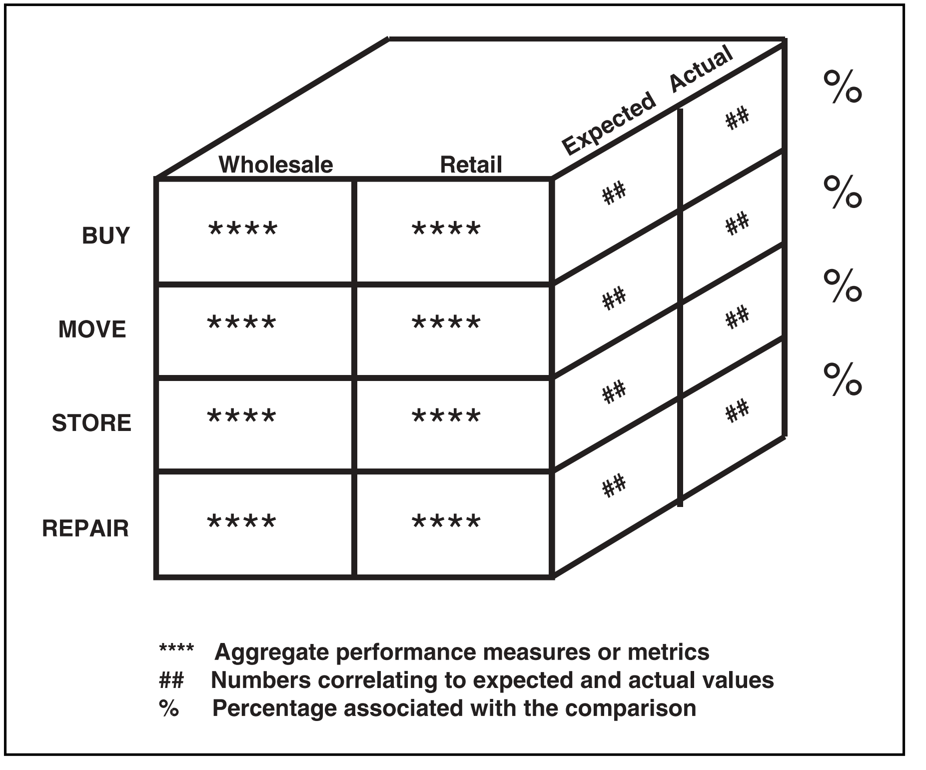


Figure 4. Three-Dimensional Considerations

Measurement Scorecard by LMI, released in March and June 1999, respectively. The *Supply Chain Master Program Plan* notes:

> These measures must represent a balance between external customer measurements, internal measurements, financial health, and learning and organizational growth. Furthermore, the measures are balanced between past results and future performance. Toward this end, many companies within private industry have implemented the balanced scorecard as both a strategic and tactical management tool.[4]

The essential element in the balanced scorecard approach is the inclusion of financial measures that show results already obtained, complementing the operational measures based on customer satisfaction, internal processes, and organizational innovation. Basically, a balanced scorecard results in a set of measures that gives strategic level managers a fast and comprehensive view of their organization. Also, the structure of the balanced scorecard forces managers to focus on only a handful of the organization's most critical measures, thereby providing answers to four basic, but essential, questions:

- How does the customer perceive our support? (customer perspective)
- What do we need to accomplish and excel at to ensure world-class support? (internal perspective)
- Do we improve our processes and continue to lead or be innovative? (innovation and learning perspective)
- How do we walk the edge between effective and efficient? Are we efficient? (financial perspective)

Figure 5 gives a graphical representation of the balanced scorecard process.[5]

Considering the uniqueness of the Air Force supply system and its processes, there is no way to clearly delineate between each of the segments of the model with respect to financial and operational perspectives. Each segment can essentially contain financial and operational (customer satisfaction, internal processes, and organizational innovation). Using the scorecard method in the traditional sense, there is no way to clearly differentiate between the segments of the supply system. To remedy this, one can simply use the balanced scorecard to *bucket* an organization's segments and metrics related to those segments. The graphical delineation of each segment of the supply system sets up a drill-down capability. The natural utility of this scorecard is that the framework can be populated with any metric representative of each segment of the supply system.

Through the last two decades, Air Force operations and logistics environments have undergone a number of fundamental changes. Logistics policies and procedures were adjusted and fine-tuned to better facilitate new operational concepts. However, many times these adjustments and, in some cases, complete changes resulted in a single area being optimized at the expense of the entire supply chain or system. In turn, many of the changes incorporated generated marginal and sometimes negative consequences.[6] To preclude this situation, the redesigned scorecard guards against suboptimizing any single segment of the supply system. By forcing senior managers to view each segment of the system, the redesigned scorecard lets them see if an improvement in one area may be at the expense of another segment of the system. For example, the Air Force uses the Economic Order Quantity (EOQ) model to control stockage policy for the retail- or base-level supply. At base level, we assume continuous demand. Even though the depot employs the same policy, at the base reorder point, the depot sees a lumpy noncontinuous demand, which, when other bases' reorder point demands occur, becomes a lumpy, unpredictable demand pattern. Thus, we optimize our expenditure at base level by employing the EOQ model but decrease our system effectiveness by not providing timely demand data to our depots.

Figure 6 is representative of the separate segments in the supply system. The characteristics of the previous figure (financial perspective, customer satisfaction or perspective, internal processes, and organizational innovation) are represented in the mix of metrics throughout the six segments, as are the system enablers—personnel, information management, organizational structure, and the policies by which the supply system is governed. These four factors correspond to internal business perspectives, essentially what a business would use to perform its function. Also, each segment interacts with or affects all segments as well as the enablers. This is shown by the arrows.

Each segment is further defined, along with metrics that measure each segment, as well as the enabler (Tables 2-4).

Analysis

This article proposes aggregate metrics that indicate the general health of supply. It does not provide a range of values for each metric. The Air Force Stockage Policy Work Group and the Air Force Supply Executive Board should determine the appropriate values for each metric.

Performance Measures

Most of the proposed metrics are AFMC centric. The rationale behind this is that AFMC plays both a, critical role in two segments of the supply system: buy and repair. Also, as noted in an earlier AFMC report, "The health of the supply chain is ultimately the supply chain manager's responsibility."[7] Table 5 provides a list of the performance metrics.

Output

The output of the supply model and system is weapon system availability—the true measure of success.

Weapon System Availability

Operational requirements are key in determining spares requirements and mixes. To that end, aircraft availability targets are used for computing inventory requirements. Aircraft availability

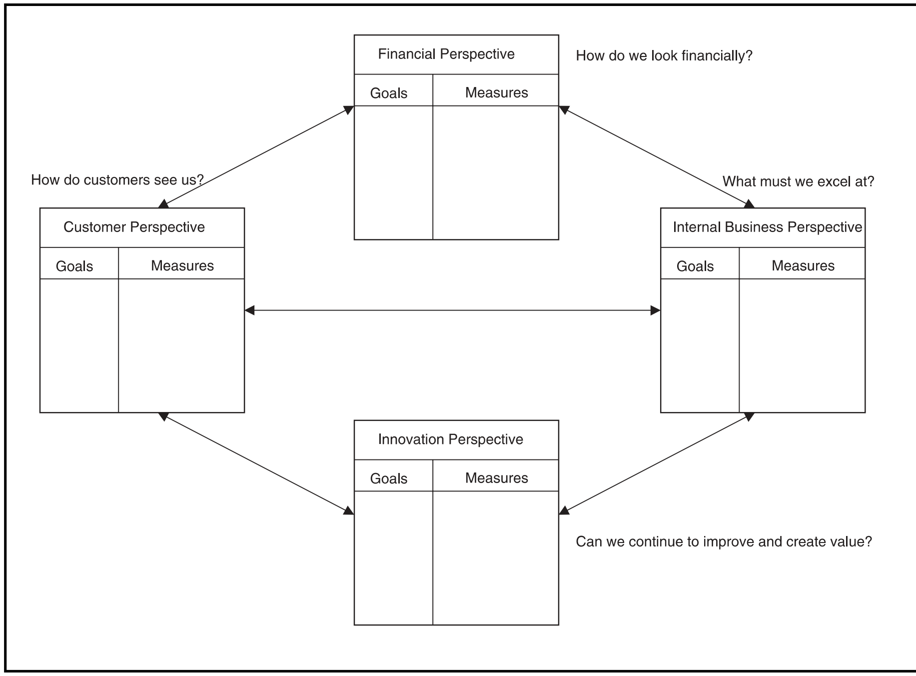


Figure 5. Generic Business Balanced Scorecard

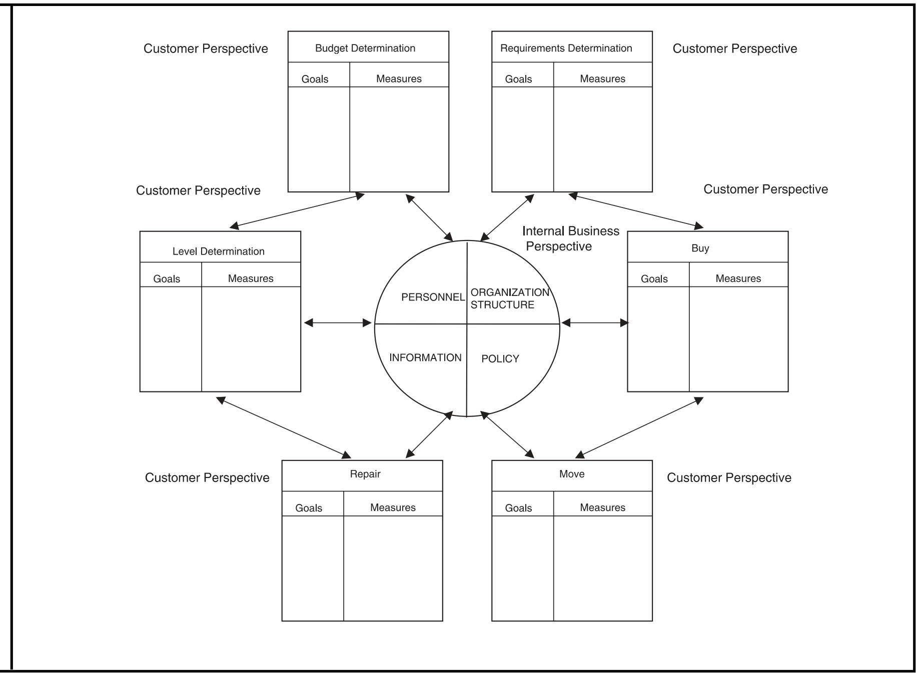


Figure 6. Supply Segment Balanced Scorecard

Input (Cash Flow/Funding and Sales		Outside Influences (DLA Responsiveness)	
Goals	**Measures**	**Goals**	**Measures**
	Funding effectiveness		IE/SE
	Sales effectiveness		MICAP incidents and hours

Table 2. Input and Outside Influences

Output		Repair	
Goals	**Measures**	**Goals**	**Measures**
	Aircraft availability (AAactual/AAtarget)		Current repair asset position
	MICAP incidents and hours Aircraft availability (crating)		Keep up
			Catchup and time to catch up
			Supply responsiveness (repair)
			Drawdown and time to draw down
			Depot repair time

Table 3. Output and Repair

expresses the percentage of aircraft not grounded due to parts (1-total not mission capable due to supply [TNMCS]). The aircraft availability targets are determined by accepting the greater of the rates required to accomplish either a peacetime or wartime operational requirement. Each weapon system has a target set with consideration of the entire Air Force inventory. For example, an F-16 target may be 89 percent, which means that only 11 percent of the Air Force F-16 fleet can be grounded (total not mission capable due to both maintenance and supply) at any time in order to meet operational requirements.

Aircraft availability targets vary from year to year, based on changes in the operational environment. These changes are mostly attributable to increases or decreases in aircraft inventories (for example, retirement of the C-141), changes in the apportionment or force structure (expeditionary

System (Information Management)		Manning (Personnel)	
Goals	**Measures**	**Goals**	**Measures**
	Significant problem items		Enlisted manning by skill-level
			Officer manning by grade

Table 4. System and Manning

Performance Metrics
Output
Aircraft Availability (AAactual/AAtarget)
Aircraft Availability (C-rating)
Repair Effectiveness
Current Repair Asset Position
Keep Up
Catchup and Time to Catch Up
Drawdown and Time to Draw Down
Supply Chain Responsiveness (Repair)
Depot Repair Time
Buy Effectiveness
Asset Position by Weapon System
Asset Position (Buy Point)
Items in Buy or on Order (Number and $)
Supply Chain Responsiveness (Procurement)
Procurement Lead-Time Effectiveness
Stockage Distribution Effectiveness
Redistribution Excess
Depot Stock Above Requirement
Customer Wait Time
Customer Wait Time (Not Meeting Expectations)
System Effectiveness (Information Management)
Significant Problem Items
Manning Effectiveness (Personnel)
Enlisted Manning by Skill-Level
Officer Manning by Grade
Sales Effectiveness
Funding Effectiveness
DLA Responsiveness
IE/SE
MICAP Incidents and Hours

Table 5. Supply Chain Segment Performance Metrics

aerospace force concept), and factor changes (sortie, turn, utilization, or attrition rates). Ideally, the workings of the Air Force supply system are designed to obtain set aircraft availability goals. How closely the system meets those availability goals provides an accounting of the overall success of all the processes and enablers involved in the supply system. Since the Air Force supply system is geared to provide targeted aircraft availability, the difference between the target and actual system performance represents inconsistency, budgetary changes or reallocation of funds, changes in OPTEMPO, or disconnects—poor forecasts or dirty data.

To measure system output effectiveness or aircraft availability in terms of readiness for contingencies, the Status of Resources and Training System requirement or the number of units by C-status (1-TNMCS) is used (Figures 7 and 8). These figures use hypothetical data.

Repair

Repair is the complement to the buy segment of the supply system model. The focus is on depot repair, since this provides an essential feed of parts to the Air Force supply system. For efficiency (funding constraints) and effectiveness (aircraft availability or mission capability), it is essential to determine if the depots are repairing what is actually needed. To do this, three cases of the repair situation need to be examined. Case 1 is *keep up*. Are the depots *keeping up* with the demand placed upon the system? Does the generation of serviceable assets equal expectations, or are the depots repairing demand? Case 2 is *catchup*. If the assets are less than levels required, do the depots *repair more than demanded to catch up*? The last case is *drawdown*. If there are more than enough serviceable assets, there is no need to repair. Have the depots *stopped repairing excess assets*? These three indicators and their derivatives provide the Air Force with a collective leading indicator that identifies the ability to repair to meet needs as well as an indicator for near-term future support.

Current Repair Asset Position

It should be noted that the analysis focuses only on national stock numbers (NSN) with a positive repair requirement in order to prevent the biasing of the statistics by including the zero requirement (Figure 9).

The first case, keep up, indicates the daily repair rate is approximately equal to the daily demand rate for a specific NSN. The depots are in a keep-up situation if the assets are approximately equal to back orders. This is measured on an NSN-by-NSN basis (Figure 10).

Next, if the system is behind or the daily repair rate is either approximately equal to or less than the daily demand rate (case 2), then the supply system is in a situation where actions need to be taken in order to catch up with the demand rate. Ideally, serviceable assets need to be approximately equal to the worldwide need. For catchup, Figure 11 applies.

If the depots keep repairing at a rate greater than system demand, eventually excess will be created—the system will catch up. To calculate the time needed to catch up, a target catchup position (TCUP) is established. TCUP, then, is back orders minus serviceable assets. Time to catch up is equal to TCUP divided by the result of the daily repair rate (DRR) minus the daily demand rate (DDR). The result illustrates the time needed for the system to catch up with demand (Figure 12).

Case 3, drawdown, exists if available assets are greater than back orders. There are times when serviceable assets are greater than the worldwide need. When this case exists, the depots must adjust the daily repair rate by NSN so that it is less than the daily demand rate. Eventually, serviceable assets will be approximately equal to need—the ideal condition (Figure 13).

If the drawdown were to continue indefinitely, the depots would get into a situation where there are

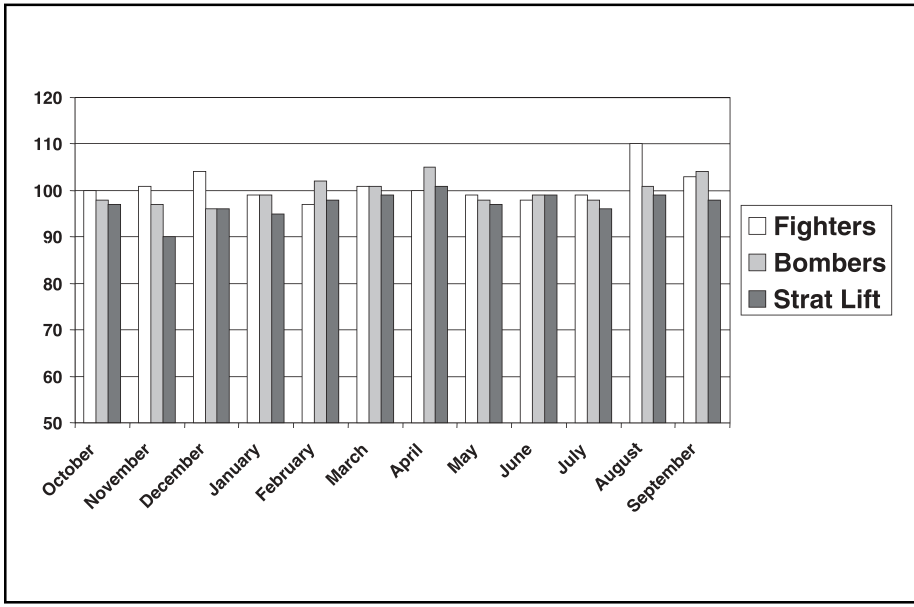


Figure 7. Hypothetical Aircraft Availability (AAactual/AAtarget)

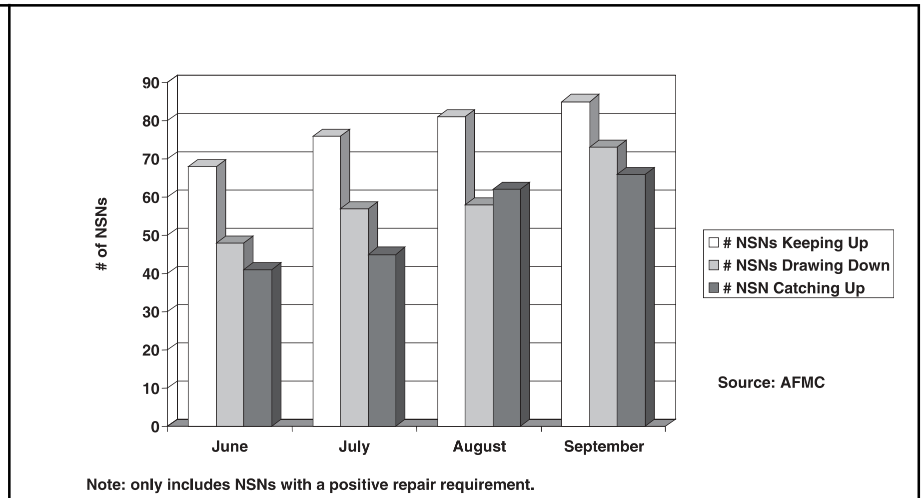


Figure 9. Current Repair Asset Position

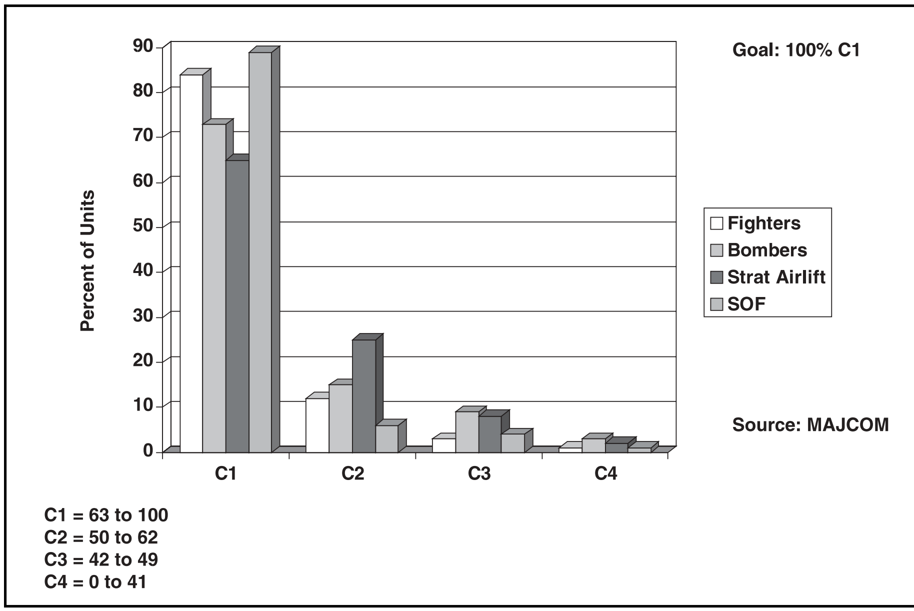


Figure 8. Hypothetical Aircraft Availability (C-Rating)

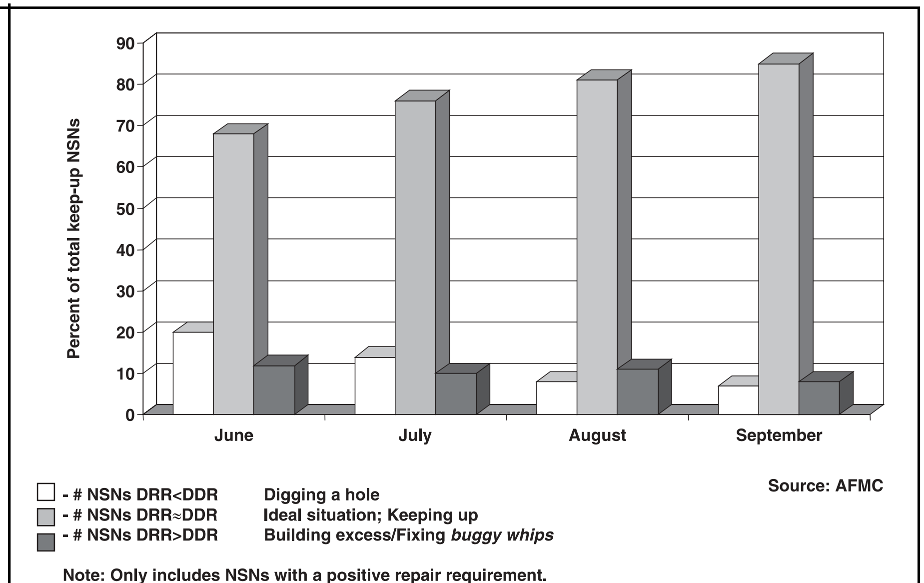


Figure 10. Keep Up (Serviceable Assets = Need)

not enough parts to meet needs. Therefore, a metric that provides the time to draw down needs to be employed, in effect letting us know when to turn off the drawdown switch. The target draw down position (TDDP) equals back orders minus serviceable assets or readiness-based leveling (RBL). The time to draw down is then calculated by dividing TDDP by the result of DRR minus DDR (Figure 14).

Collectively, a good measure of time for the repair segment is the metric depot repair time (Figure 15).

The responsiveness of the depots within the supply system must be considered. The metric supply chain responsiveness measures depot performance versus customer expectations in terms of both procurement and repair (Figure 16).

Buy Effectiveness

Buy effectiveness shows whether the depots are buying what is needed to support repair in meeting the worldwide demand. Like repair, buy effectiveness is a collection of measures that provides an indication of how well the buy segment is functioning. It can be measured for three cases: no buy, buy, and unneeded buy. *No buy* is the case where existing physical assets, excluding on-order assets, meet current and project need or demand. Essentially, the Requirements Management System (RMS) buy computation is equal to zero. The next case is *buy*. In this case, the number of assets on order is compared to the need. The RMS buy computation is greater than zero. The last case is the *unneeded buy*—items on order are more than needed. The buy computation is equal to zero, but items are on order. An important aspect of buy effectiveness is the time element of this segment. Will the needed assets, once we have determined they are indeed needed, arrive in a timely manner? It should also be noted the metric supply chain responsiveness, in terms of procurement, is applicable in this segment. However, the metric is not displayed, since it was previously shown. A measure of the timeliness of the buy segment is the metric procurement lead-time effectiveness. Essentially, this measure looks at a percentage of procurement actions in buckets of time. It is the aggregate metric of this segment of the supply system (Figure 17).

This Asset Position by Weapon System chart lets management know the mix of NSNs where physical assets (on hand) meet or do not meet needs for the current quarter. Since this metric illustrates the asset position by weapon system, specific asset shortages can be related to expected weapon system or aircraft availability.

To further delve into asset position, one needs to look at the buy point (Figure 18).

Three conditions need to be examined:

- The buy is greater than the need—physical assets meet demand, but items are on order.
- Physical assets do not meet demand, and items are on order but not in sufficient quantities to eventually meet the need.
- Physical assets do not meet current need, but the items on order are equal to or greater than the current demand.

Figure 19 includes the aforementioned situations.

An associated dollar value needs to be included in the metric (Figure 20).

Procurement lead-time effectiveness also needs to be considered. Wholesale procurement lead times are the sum of administrative lead times (ALT) and production lead times (PLT). ALT can be thought of as paper work time, while PLT is the time required to manufacture and deliver an item. A simulation run by LMI—documented in *Parts Delays at Maintenance Depots' A Significant Problem* (D. Zimmerman, T. Bachman, and K. Kiebler, December 1999)—shows that reducing procurement lead time reduces back orders (Figure 21).

Stockage and Distribution Effectiveness

With the shift to a transportation-centric focus, rather than relying on large inventories (meet demand and account for forecasting difficulties), stockage/distribution effectiveness is becoming an increasingly important segment of the supply chain. Stockage/distribution effectiveness determines whether the stock on hand is at the right location. Within the supply system, one often discovers items at one location that are excess to requirements at that location but not excess to the overall system or global requirement. These are redistributable items and can be employed to meet requirements at another location. In terms of these assets, the following equations apply.

Redistributable asset = (serviceable balance + war reserve materiel [WRM]) - (requisition objective + base due out + unconfirmed RDO) = 0: ideal state, which means no excess to distribute

Redistributable asset = (serviceable balance + WRM) - (requisition objective + base due out + unconfirmed RDO) > 0: excess, which means there is excess to distribute

The total amount needed elsewhere is designated by depot back orders (Figure 22).

This segment also measures the effectiveness of the forecast-and-buy execution by exploring Air Force inventory reduction goals—number of NSNs serviceable on hand that are greater than the requisition objective divided by annual demand (Figure 23).[8]

A measure of timeliness of the supply system distribution system is customer wait time—a paramount focus in supply chain management. A customer-defined expectation is represented by the following metrics. Customer wait time provides a measure of the time element involved in supply chain (Figure 24).

Customer wait time (not meeting expectations) provides management a system performance metric

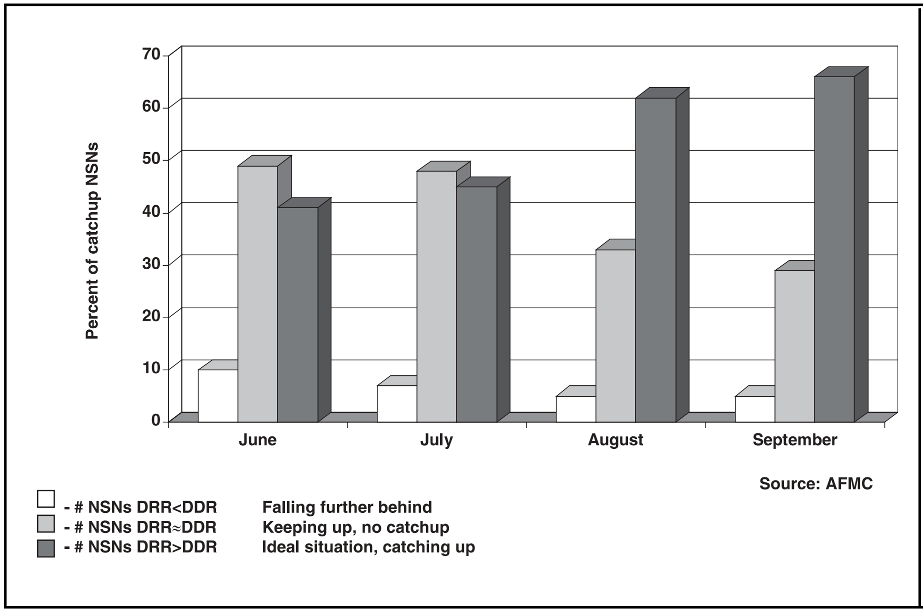


Figure 11. Catchup (Serviceable Assets < Needs)

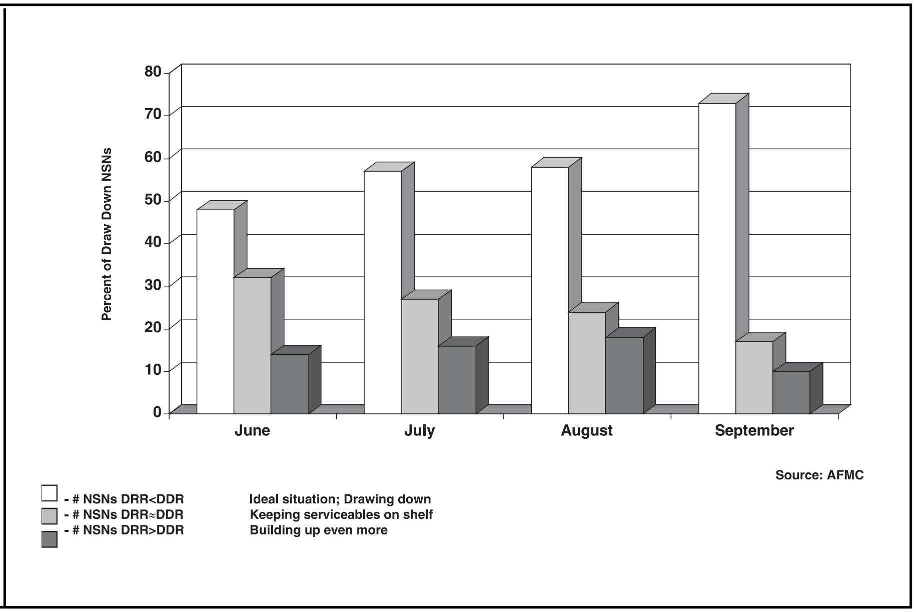


Figure 13. Drawdown (Serviceable Assets > Need)

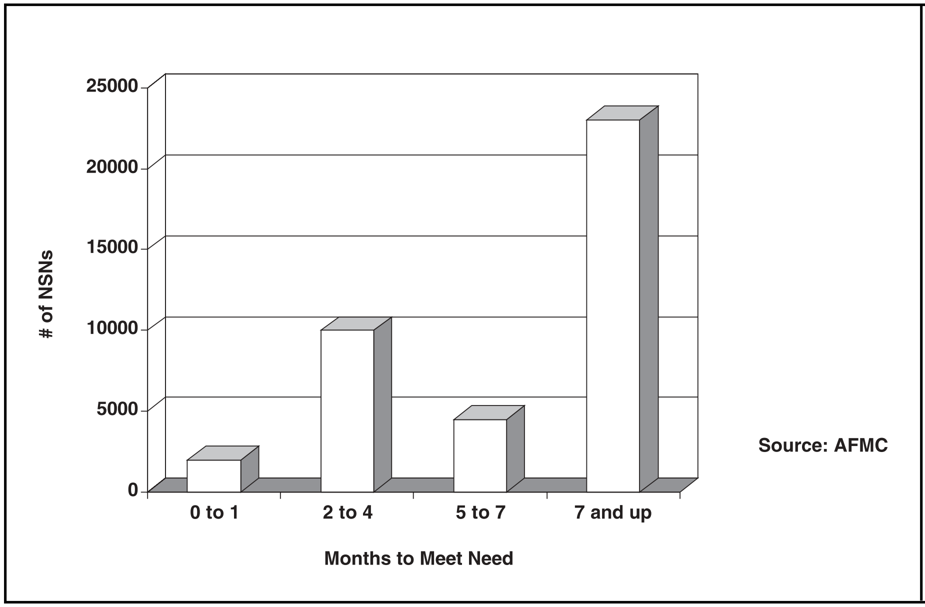


Figure 12. Time to Catch Up

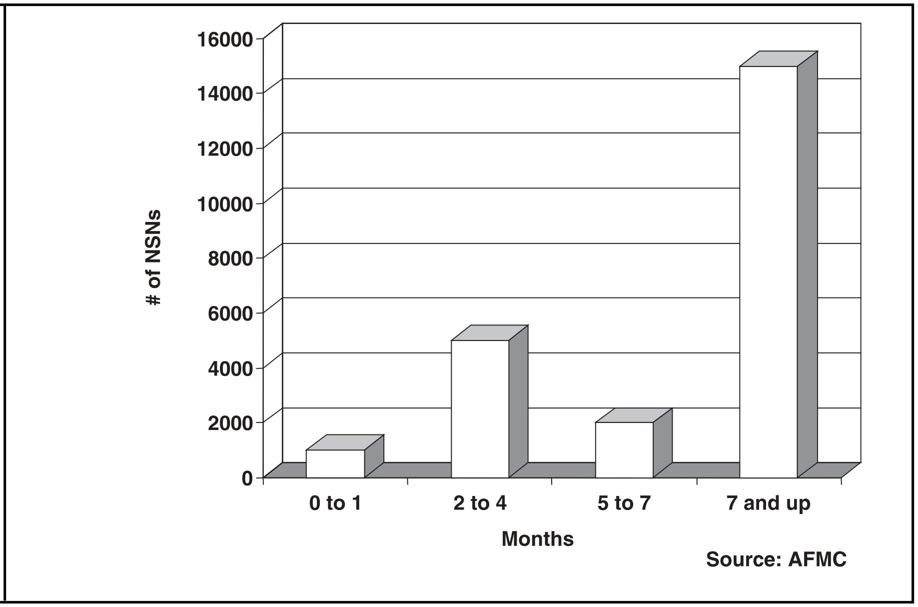


Figure 14. Time to Draw Down

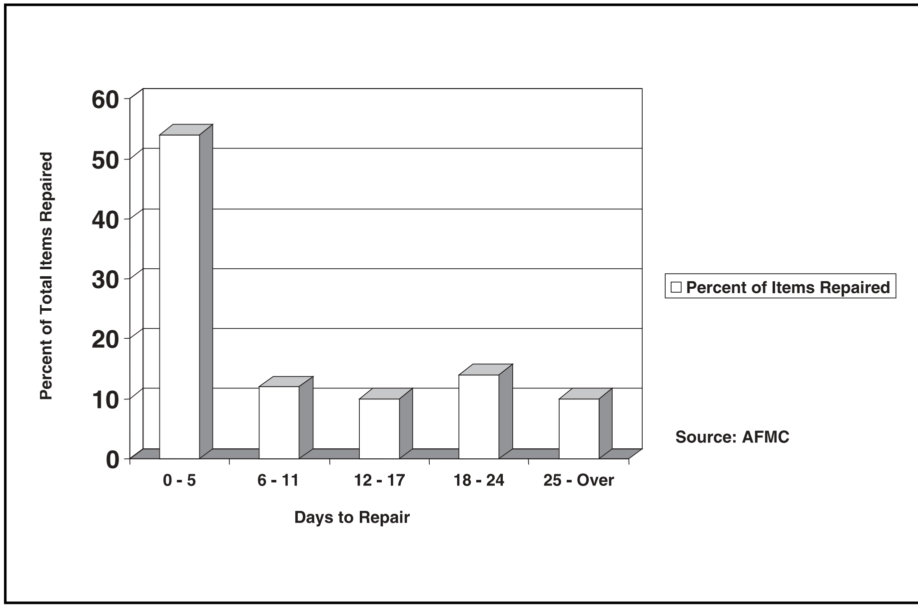


Figure 15. Depot Repair Time

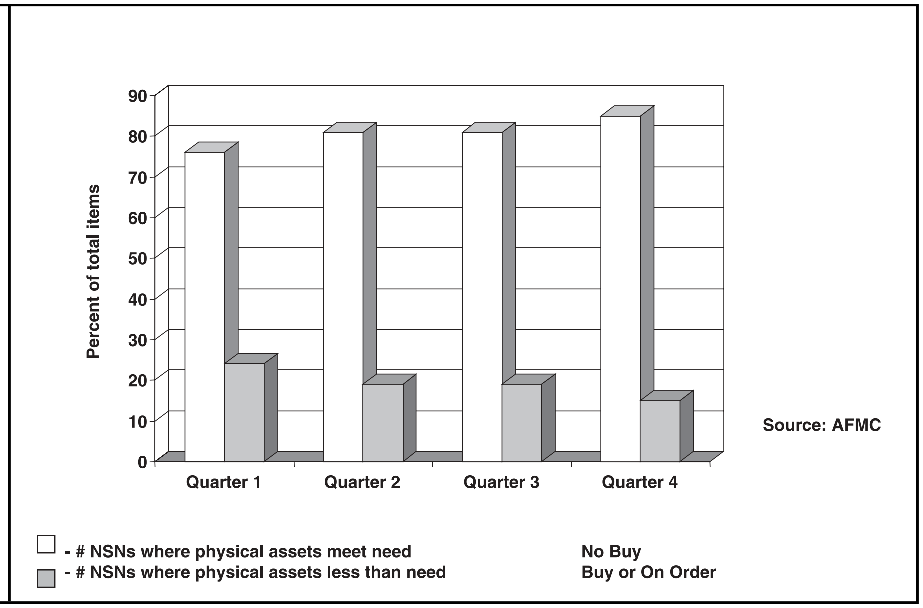


Figure 17. Asset Position by Weapon System

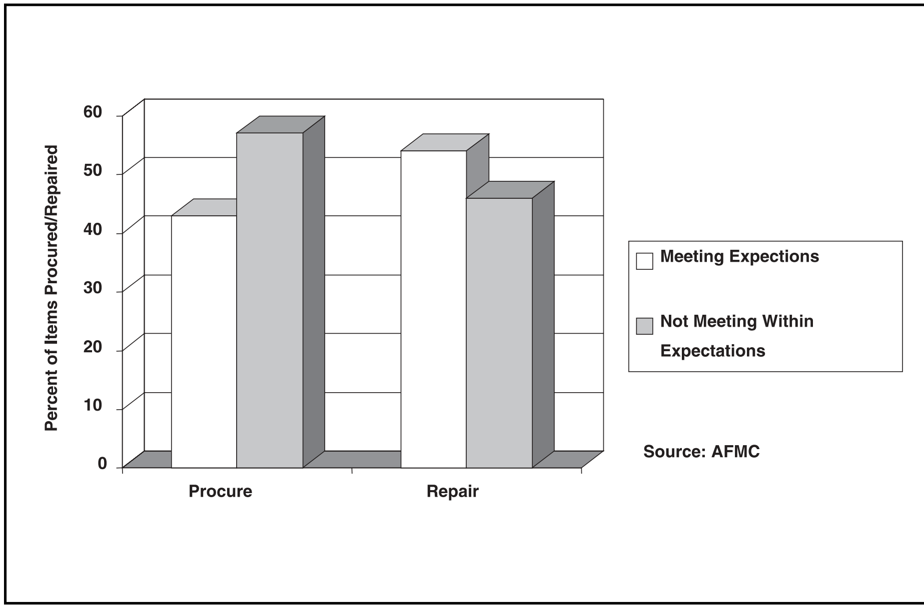


Figure 16. Supply Chain Responsiveness

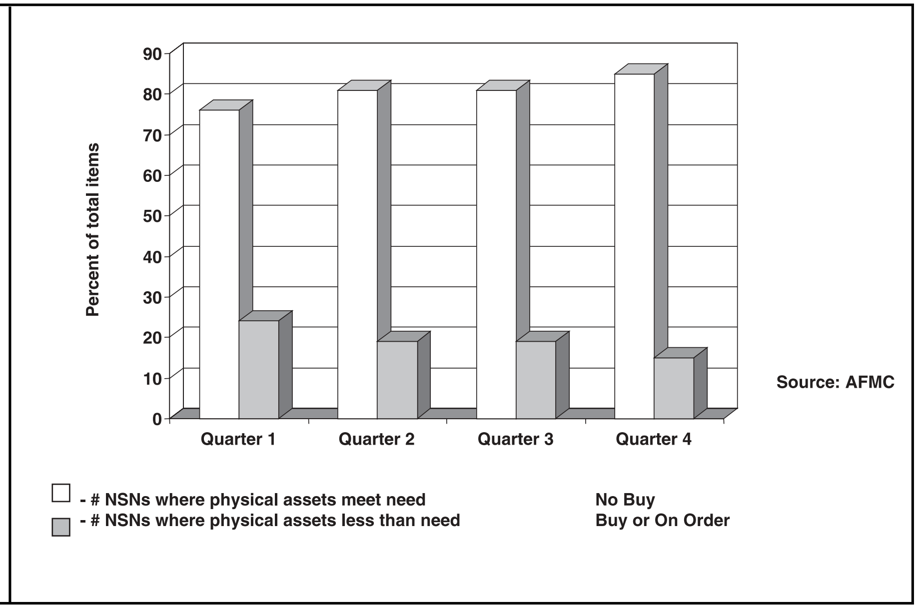


Figure 18. Asset Position (Buy Point)

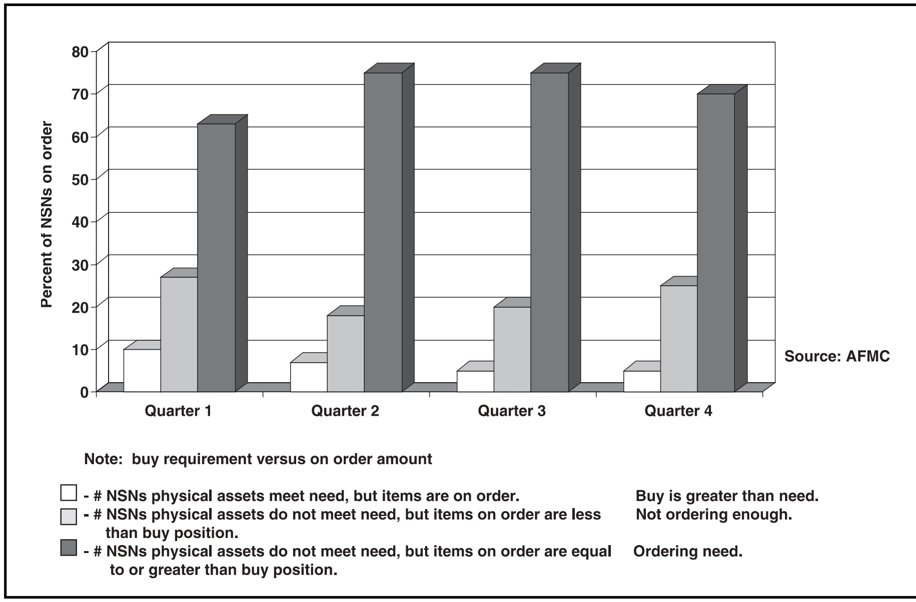


Figure 19. Items in Buy or on Order

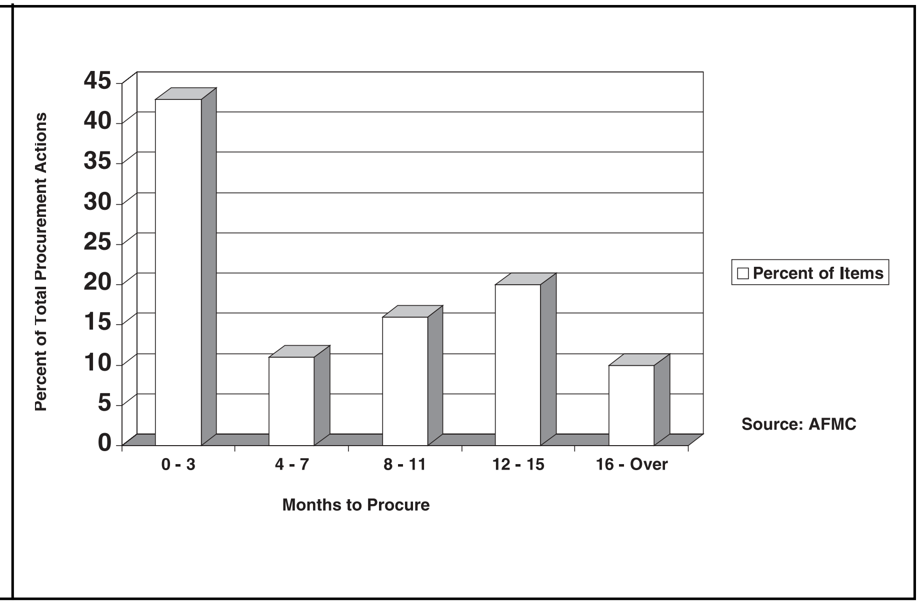


Figure 21. Procurement Lead-Time Effectiveness

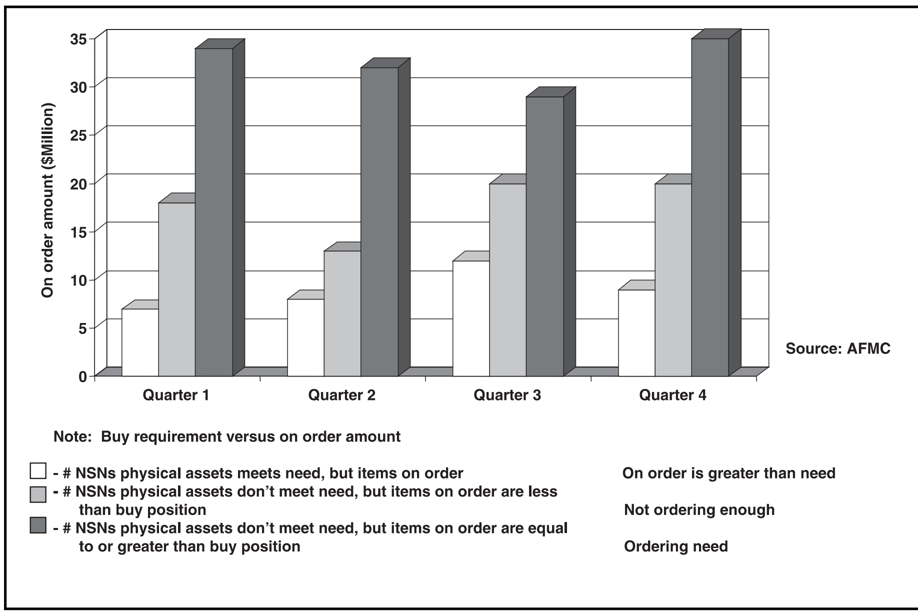


Figure 20. Items in Buy or on Order ($)

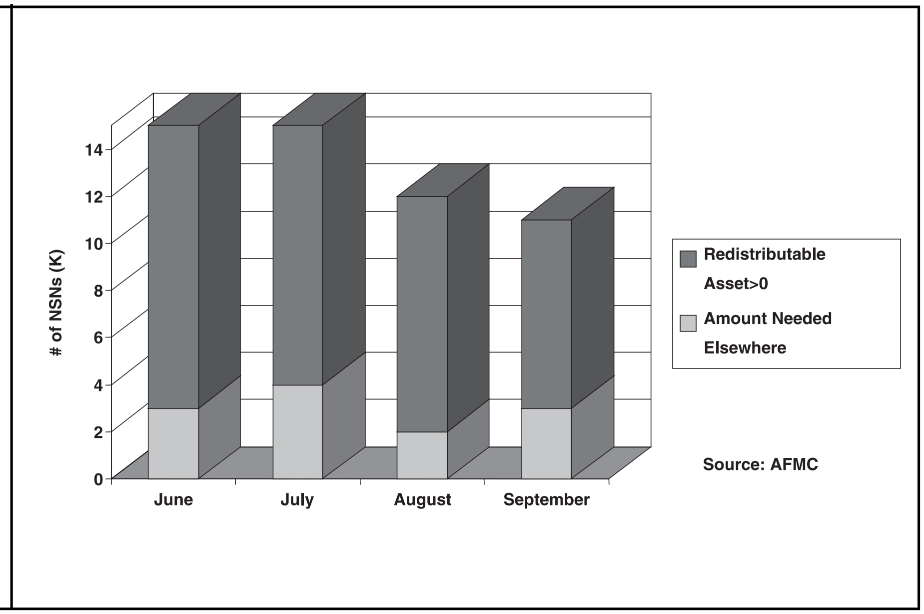


Figure 22. Redistributable Excess

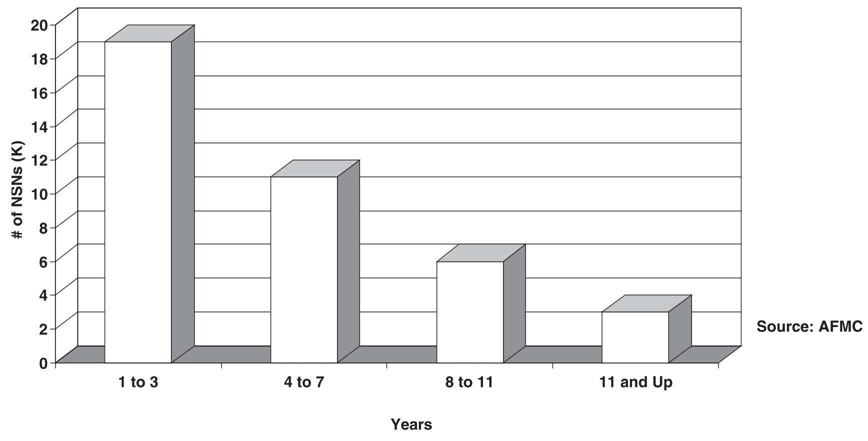


Figure 23. Depot Stock Above Requirement

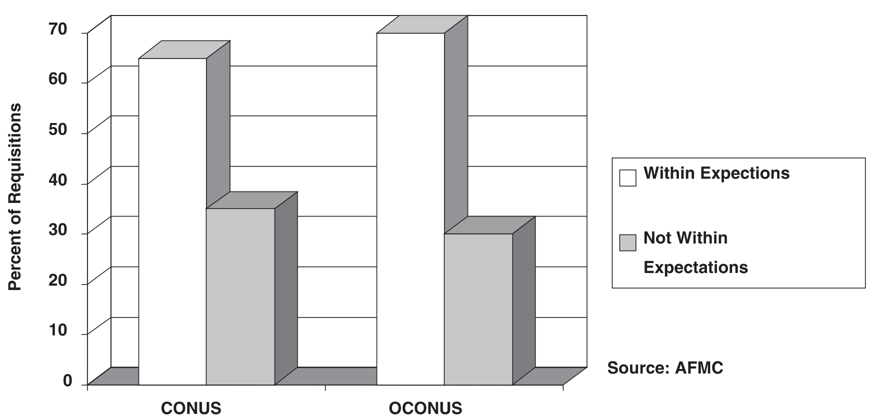


Figure 24. Customer Wait Time

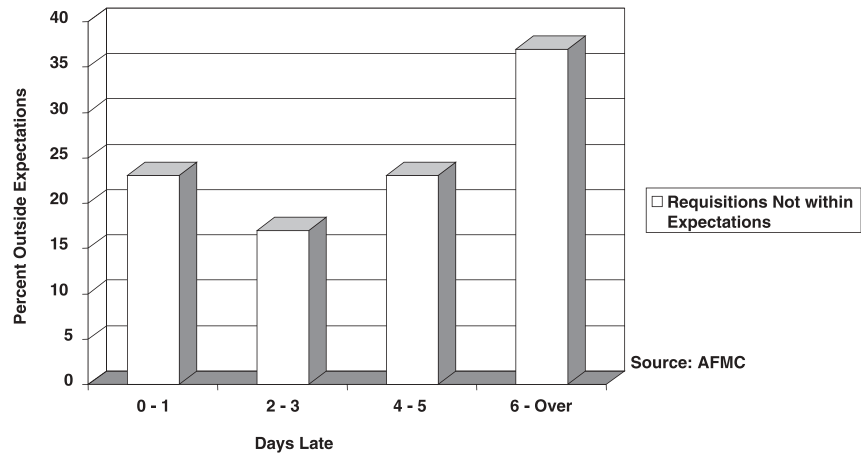
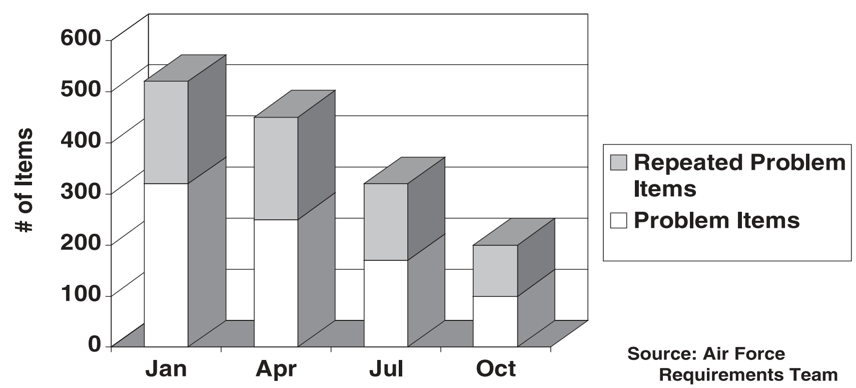


Figure 25. Customer Wait Time (Not Meeting Expectations)



Note: Requirement not sufficient and creates significant EBOs

Figure 26. Significant Problem Items

that defines the success of the system in meeting customer expectations (Figure 25).

System Effectiveness

"It is impossible to achieve world-class standards without world-class logistics information systems."[9] As previously mentioned, informational management is transparent throughout the entire supply system or chain but is a huge contributor to overall system performance and success. It is an enabler of each phase of the supply process. However, how is information management or communication capability measured? Performance capabilities of a data communication system are best assessed in the context of the objectives of a particular logistics system. Some of these objectives may include (1) improving customer service; (2) shortening the time required to determine stock availability in order to provide assets more rapidly to customers; (3) reducing inventories without delaying order shipments; and (4) reducing the costs of order processing, inventory management, and related data-processing tasks. Also critical is ensuring the right data get to the right point in the system.

Other than people, information—and its reliable and timely flow—is probably the most important enabler of the supply chain. Reliability of the data is critical. Unreliable or *dirty* data have proven to be extremely costly to the Air Force. The AFLMA study *Analysis of the Supply Requisitioning System and Impact on Lean Logistics Implementation* found significant disparities between requisition databases and the retail and wholesale segments of the supply system. The results of the study indicated that dirty data were responsible for an average 15 percent error for all base requisitions and 20 percent for requisitions resident at depot level. Dirty data are the result of communication interface problems, human error, system disconnects, or other problems. Data corruption of this type can result in maldistribution of assets, wrongly spent repair dollars, poor customer support, and degraded mission capability. Given the current systems used to transmit data, data corruption will continue to occur. With this in mind, along with the overriding need to have correct data, some measure of the Air Force's ability to resolve data problems is essential, particularly in light of the need to make the requirements-based system as effective and efficient as possible.

In some cases, the worldwide requirement may not be sufficient to satisfy the base needs. That is, there may be times when the worldwide requirement did not meet the computed worldwide pipeline (to include adjusted stock levels). The D200A worldwide requirement should always be at least equal (within rounding) to the expected pipeline. Incomplete data due to data transmission errors (dirty data) could be the cause for those cases where the D200A requirement fails to meet the expected pipeline. For example, input data to D200A did not include adjusted stock levels or accurate base-level data.

There are two groups of problem items (N and Z) where the base and D200A databases are so inconsistent (data are suspect) that readiness-based leveling does not push levels to the bases. These problem items usually mean inadequate requirements and need immediate AFMC-item-manager action. Figure 26 shows the cases where RBL did not push a level because of N and Z problem items.

N problem items represent items where the requirement is insufficient to meet the base needs (the requirement does not cover the worldwide pipeline, and the expected back orders are greater than two). RBL will not push levels to users for these items (meaning the repair cycle, demand level remains in effect). AFMC materiel managers must review and update the requirement, if necessary, so RBL can be rerun for this item. Z problem items represent the cases where D200A has computed a zero requirement and the base has sufficient need to compute a total worldwide pipeline that at least rounds to one. That is, if D200A had the correct base-needs data, it would compute a requirement greater than zero.

Manning Effectiveness

The most important enabler within the supply chain is the human factor. Accordingly, we measure supply manning levels for war-tasked, traditional supply, as well as other significant areas. For the enlisted, we look at assigned versus authorizations by skill-level in supply, outside of supply, and unit type code (UTC) tasked. For officers, we look at assigned versus authorized by rank across the same categories as the enlisted (Figures 27 and 28).

Sales Effectiveness

Is the Air Force collecting the funds necessary to pay for forecasted buy-and-repair requirements? To show this, sales compared to forecasted requirements need to be measured. This can be done by weapon system, supply chain manager, or major command (Figure 29).

Funding Effectiveness

The essential input to the supply system is funding. To get an accurate picture of how funds are used to meet requirements, we can measure the cost-per-flying-hour requirement to the real requirement (needed quantities computed by the D200A system, now D200A) against available funding. This identifies the total requirement compared to the operations and maintenance budget and actual funding (Figure 30).

Defense Logistics Agency Responsiveness

An integrated partner in the Air Force supply system is the Defense Logistics Agency (DLA). Considering the volume of business the Air Force does with DLA, its well-being and responsiveness are certainly important. To evaluate DLA and its commitment to the Air Force as a supply chain partner and customer, several traditional measures can be used. Instead of fill rates or supply availability, which can slant meaning, issue-and-stockage effectiveness based on commodity, the

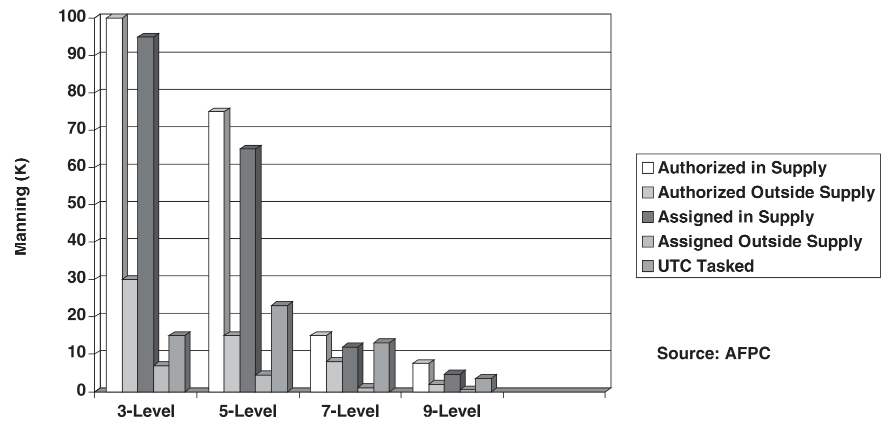


Figure 27. Enlisted Manning by Skill-Level

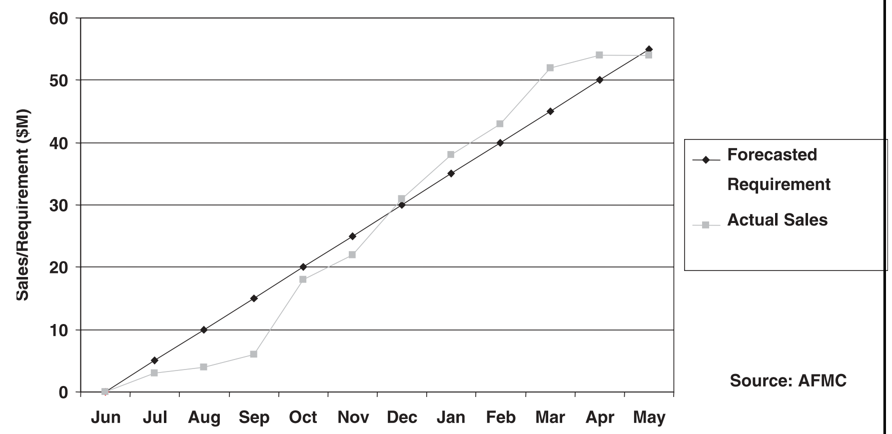


Figure 29. Sales Effectiveness

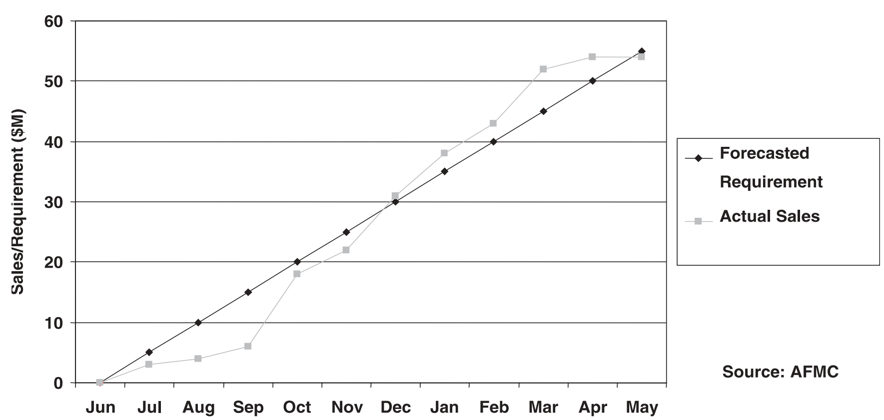


Figure 28. Officer Manning by Rank

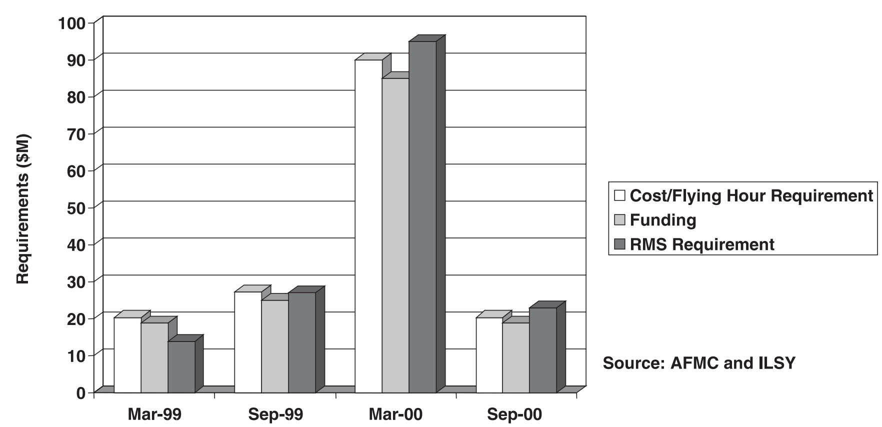


Figure 30. Funding Effectiveness

base, and the DO35K can be examined. Supply availability speaks to the percentage of orders filled. If there is a large order that cannot be filled and several small orders that can be, the smaller orders will be filled. The one large order that cannot be filled, even if it is a bulk order for more than 1,000, does not proportionally penalize DLA. Another traditional measure that can be used to gauge DLA's support is MICAP incidents and hours by acquisition advice code and numerical stockage objective and insurance items. The following discussion, even though Air Force data are used in the graphs, needs to be applied to DLA.

Air Force Issue/Stockage Effectiveness

Issue effectiveness: a customer support measurement identifying an account's ability to satisfy a customer demand (issue the item off the shelf versus back ordering). The Standard Base Supply System (SBSS) Management Report (M32) computes Air Force issue effectiveness as a percentage of the total number of items issued compared to the total number issued and back ordered.

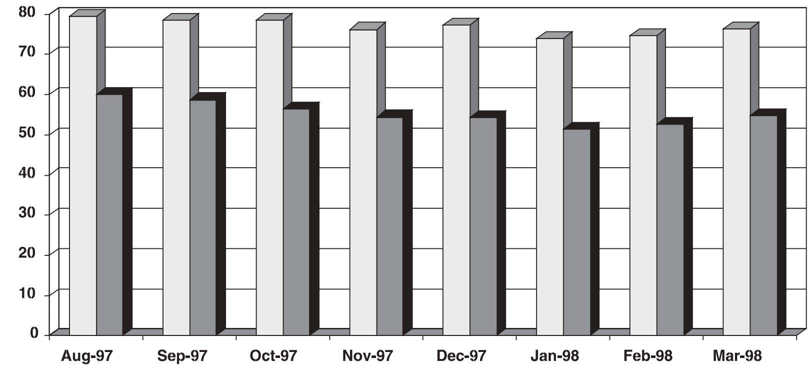
Issue effectiveness = (items issued)/
(items issued + back orders)

Air Force stockage effectiveness is the percent of demands satisfied from shelf stock, excluding back orders for items that the base is not authorized to stock. These *not-authorized-to-stock* back orders are categorized as type transaction phrase code 4W in the SBSS. The SBSS Management Report (M32) computes Air Force stockage effectiveness using the formula below:

Stockage effectiveness = (items issued)/(items issued + items back ordered – 4W back orders)

Figure 31 is an example of the issue-and-stockage effectiveness metrics using actual M32 data (from the Multi-Echelon Research and Logistics Information Network [MERLIN]) for August 1997 to March 1998.

Since 1997, the Dynamic Research Corporation (DRC) has been responsible for collecting and storing base-level M32 data to compute issue-and-stockage effectiveness. Each base (SBSS host account) processes the M32 monthly and generates files that are then sent to DRC. The DRC-developed MERLIN system is used to store and roll up the M32 data and provide issue-and-stockage effectiveness to the Air Force.



	Aug-97	Sep-97	Oct-97	Nov-97	Dec-97	Jan-98	Feb-98	Mar-98
Stockage Effectiveness	79.5	78.5	78.4	76.2	77.3	74	74.6	76.4
Issue Effectiveness	60	58.7	56.4	54.4	54.2	51.4	52.5	54.7

Figure 31. Issue-and-Stockage Effectiveness

MICAP Incidents

In a previous AFLMA report, *RBL and Redistribution Order (RDO) Performance Metrics*, LS199805700, the importance of MICAP-related measures for the Air Force is demonstrated. The same logic regarding DLA support is applicable. Table 6 gives examples (from April 1997 to March 1998) that measure grounding (MICAP) incidents and hours. The Weapon Systems Management Information System (WSMIS) provided the data for each of the metrics. Figures 32 and 33 show the historical number of MICAP incidents and hours along with the average hours per incident. Supply managers strive to reduce both the number of incidents and the length of weapon system grounding incidents.

MICAP Incidents by Cause Code (XB and Some XF ITEMS)

Figures 34 and 35 are examples of metrics that show MICAP incidents by cause and delete codes respectively. A MICAP cause code identifies the reason stock was not available to satisfy the issue request and provides management data to prevent or reduce future MICAP incidents. Delete codes indicate how MICAP was satisfied. MICAP delete codes are useful as predictors of problems. For example, increases in cannibalizations and lateral support might indicate a shortage in base and depot stock levels. Cannibalizations and lateral support are workarounds and generate man-hours to temporarily solve the past shortage.

Proposed Data Collection and Reporting Process

The next portion of this article presents a proposed data collection process. For each metric, the proposal includes who should collect the data to build the metrics, how it should be collected, and when (frequency) it should be collected. Also indicated is availability of the metric.

Proposal

Most of the data for the metrics can be provided now (in the near term) by five sources: (1) MERLIN via the SBSS, (2) RBL, (3) WSMIS, (4) D200A, and (5) DO35. MERLIN provides the issue-and-

	Apr 97	May 97	Jun 97	Jul 97	Aug 97	Sep 97
MICAP Period Hours	5,595,452	5,835,978	5,513,117	5,975,553	6,714,075	6,441,450
Active MICAP Incidents	25,576	25,515	25,257	26,694	27,061	27,0118
Avg Hours Per Incident	218.7774	228.7273	218.3808	223.8538	248.1089	238.4133
	Oct 97	**Nov 97**	**Dec 97**	**Jan 98**	**Feb 98**	**Mar 98**
MICAP Period Hours	6,602,506	6,605,843	6,549,301	6,817,218	6,280,872	6,611,501
Active MICAP Incidents	28,627	26,752	26,717	28,733	29,082	30,298
Avg Hours Per Incident	230.6391	246.9289	245.1361	237.2609	215.9711	218.2158

Table 6. Average MICAP Incidents and Hours

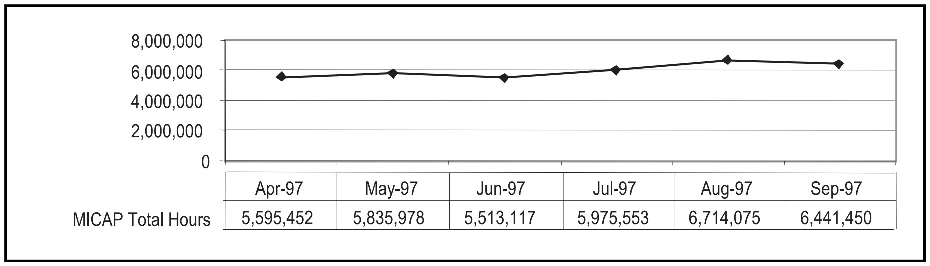


Figure 32. MICAP Hours

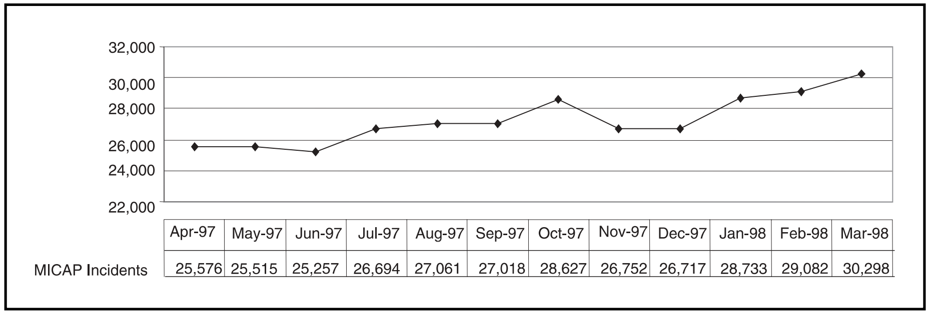


Figure 33. Active MICAP Incidents

stockage effectiveness data (via the M32 Monthly Base Supply Management Report) as well as the information to determine the actual versus expected for aircraft availability. RBL provides the central level summary and other reports needed for the information management metrics (significant problem items). WSMIS provides the data to generate the MICAP incidents and MICAP hour's metrics. Finally, D200A and DO35 provide the buy, repair, and depot-specific data necessary for the depot-focused metrics. On a long-term basis, the future modernized SBSS (otherwise known as Integrated Logistics System-Supply [ILS-S]) should provide the data for all performance metrics except those provided by RBL for the information management performance metric. The modernized supply system will, for example, provide both stockage and issue effectiveness at several levels by national stock number, major command, base, weapon system, and overall Air Force. The system will also provide global MICAP data as well as other data. Therefore, for ILS-S requirements documentation purposes, we propose ILS-S provide issue-and-stockage effectiveness, average MICAP hours per incident, hours by period, active incidents, data by cause code, and data by delete code as well as the pertinent information for the construction of the AFMC-centric metrics.

Conclusions and Recommendations

Conclusions

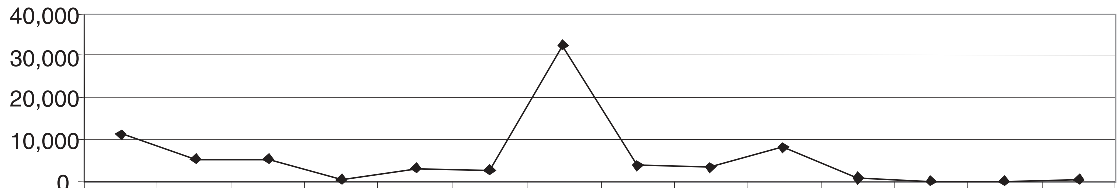
A formal system needs to be developed to collect and filter the data needed to populate the ILS-approved aggregate health of supply performance metrics.

Review of the performance metrics will ensure the efficient and effective allocation of the requirements and distribution of assets.

The appropriate agencies or functions should review the performance metrics periodically (at least annually) to determine if Air Force stockage policies need to be changed or adjusted to *revive* the *health* of supply.

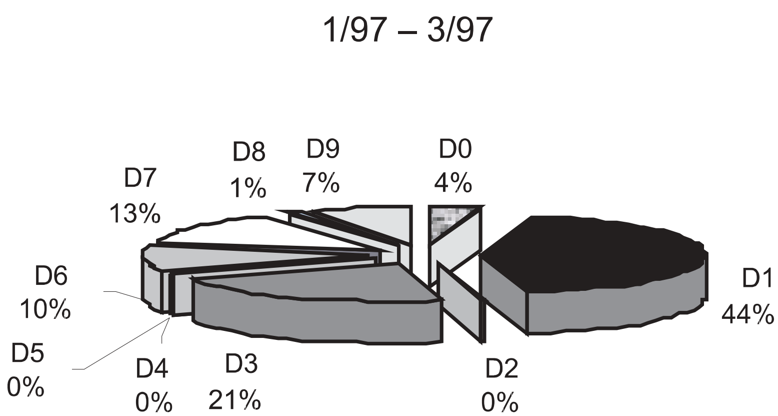
Recommendations

- Adopt the metric set (indicators of the general health of the supply system) outlined in this article to ensure the effective and efficient operation of the supply chain.



	A	B	C	D	F	G	H	J	K	R	S	T	X	Z
QTR 1	11,265	5,263	5,035	499	3,071	2,755	32,583	3,566	3,297	8,012	660	52	45	245

Figure 34. MICAP Incidents by Cause Code



	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9
Jan 97	318	3,736	34	2,128	2	41	882	860	106	648
Feb 97	252	3,542	16	1,566	2	24	1,010	1,232	52	610
Mar 97	426	4,828	28	2,210	0	22	1,026	1,624	58	774
	996	**12,106**	**78**	**5,904**	**4**	**88**	**2,918**	**3,716**	**216**	**2,032**
	.04	**.43**	**.00**	**.21**	**.00**	**.00**	**.10**	**.13**	**.01**	**.07**

Figure 35. MICAP Delete Codes

- The review of the metrics will ensure the efficient and effective operation of the supply chain. The Air Staff should ensure the Air Force Stockage Policy Work Groups and Air Force Supply Executive Board are briefed on the metrics respectively.
- The proposed process for collecting and presenting the data for the metrics should be implemented.

Notes

1. Larry S. Klapper, et al, LMI, Supply Chain Management: A Recommended Performance Measurement Scorecard, LG803R1, Jun 99, 3-3
2. *Ibid*.
3. AFPAM 36-2241, *Promotion Fitness Examination Study Guide*, Vol I, 1 Jul 95, 37-38.
4. Supply Chain Management Master Program Plan, AFMC, Mar 99.
5. *Harvard Business Review,* Feb 92.
6. Supply Chain Management Master Program Plan.
7. AFMC FY00 to FY00 Strategic Plan, Oct 99.
8. Changes in national defense strategy led to a comprehensive program to resize our inventories while maintaining a certain level of readiness. A recent General Accounting Office report estimated that $41B of DoD inventory is unneeded. After much debate as to what is excess, $300M was categorized as *potential reutilization/disposal* stock, which means it awaits disposal.
9. E. H. Frazelle, World-Class Warehousing: Timeless Insights for Planning, Designing, and Managing Warehouse Operations, Logistics Resources International, Inc, 1996.

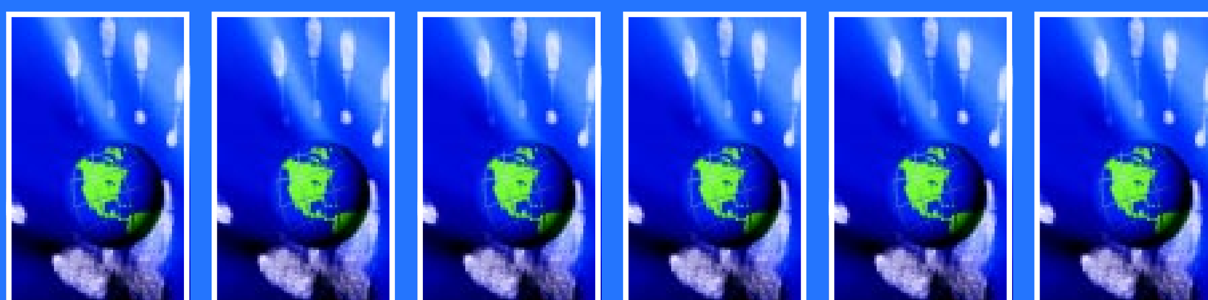
Teamwork allows us to be an effective fighting force—a rapid expeditionary force capable of deploying anywhere in the world in a minimum of time and in austere conditions—not operating from where we are stationed, but from where we are needed, not when we can, but when we must.

—General Michael Ryan, USAF

STEPHEN HAYS RUSSELL, PHD

Logistics managers need to become aware of the growing risks of becoming a victim of logistics crime.

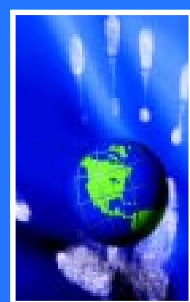
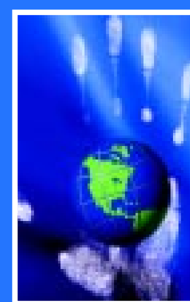
Global Logistics Crime: Managing the Risks



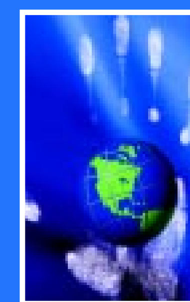
The growth in logistics crime in the last decade has gone from random and insignificant to a serious problem.

Logistics managers devote substantial skill and effort in designing efficient and responsive logistics systems. Sometimes, however, external shocks or changing circumstances require the best of logistics systems to be modified or to respond and adapt in unexpected ways. Such is the situation today in domestic and global logistics networks that must deal with the burgeoning problem of logistics crime.

Consider these recent events that are symptomatic of the growing problem of logistics crime both abroad and domestically:





- Masked robbers brandishing pistols burst into an Irvine, California, distribution center, tie up warehouse employees, shoot to death an escaping dock worker, and use the firm's own truck to load up and make off with more than $12M in memory chips and circuit boards.
- A senior buyer for a nationally prominent firm is charged in Kentucky with accepting bribes from at least two of the firm's major suppliers over a period of years. Contracts in the millions of dollars are involved.
- In one of Colorado's largest cargo thefts ever, more than $600K worth of Macintosh computers are stolen from a parked C. R. England trailer.
- Armed pirates in a small motorboat board a 20,000-ton container ship in a safe anchorage area outside the harbor at Rio de Janeiro at midnight. The night watchman is apprehended at gunpoint. A second boat approaches them, and more armed pirates climb aboard. The crew is subdued at gunpoint, and the captain is confronted and required to open two safes and to reveal the vessel's stowage plan. A third boat comes alongside the ship, and massive amounts of high-value cargo, cash, and the crew's valuables are taken.
- Armed bandits in Mexico, posing as highway police, commandeer a trailer loaded with $300K worth of merchandise from the United States. The rig is later found (empty).

The most burgeoning problems are cargo theft (domestically and internationally) and piracy on the high seas.

- In Dade County, Florida, a driver shows up at the freight forwarder and picks up a trailer full of fashion merchandise. The crime is discovered when the real driver shows up 30 minutes later. Logistics managers devote substantial skill and effort in designing efficient and responsive logistics systems. Sometimes, however, external shocks or changing circumstances require the best of logistics systems to be modified or to respond and adapt in unexpected ways. Such is the situation today in domestic and global logistics networks that must deal with the burgeoning problem of logistics crime.
- Last fall at the port of Los Angeles where intermodal containers were strewn about awaiting transport, in the early morning hours, thieves cut a security fence and stole the contents of ten containers, bringing the number of stolen or pilfered containers at that port for the year to more than 400.
- On I-880 north of San Jose, California, a van with no license plates pulls alongside an 18-wheeler that just left a computer supplier and tries to get the driver to pull over. When the driver ignores the attempt, the van's occupants open the side door and brandish assault rifles. The truck driver instinctively swerves toward the van in an attempt to drive them off the road. The van brakes and scrambles away.

This article addresses the nature, prevalence, and impact of logistics-related crimes on supply chain players and action logistics managers can take to control their exposure to logistics crime. Emphasis is on cargo theft, which is pandemic with invasion robberies, piracy, and hijacking.

The Nature of Logistics Crime

In today's environment logistics-related crimes can and do occur at any point in the supply chain. The harsh reality is that all points and all players are potential targets for this kind of crime.

Table 1 categorizes logistics crime from the manufacturer or shipper's perspective. Two major categories of crime, onsite and offsite, exist. Onsite crimes occur at the manufacturer, depot, or distribution facility. Offsite crimes occur at a third-party operation, typically when components or products are either in a carrier's transportation equipment or facility or in a public warehouse.

Onsite Crimes		Offsite Crimes	
Insider*	**Outsider***	**Insider***	**Outsider***
			Cargo theft on station
Pilferage	Invasion robbery	Pilferage	Invasion robbery
Theft	Burglary	Fraud	Burglary
Fraud			Thief driver
Bribery			Document fraud
			Phantom ships
			Cargo theft off station
			Document fraud
			Trailer/container theft
			Hijacking
			Piracy

Note: Crimes ancillary to logistics include drug smuggling, money laundering, and transportation of illegal aliens.
*Insider/outsider categories relate to perpetrators. Any category of logistics crime may involve insider information.

Table 1. Categories of Logistics Crime

Onsite and offsite crimes can be further stratified into two subcategories: insider and outsider crime. Insider crimes are those that are committed by employees of either the firm or a third-party logistics services provider. Outsider crimes, although often facilitated by insider information, are committed by people external to the legitimate logistics network. Within each of these subcategories, the following types of crime can be identified.

- **Pilferage**. The stealing of incidental quantities of materials or merchandise or theft of part of the contents of a shipping package is pilferage.
- **Theft**. The term theft is used when whole cases, pallet loads, or containers of items are stolen. Whereas pilfered items are typically taken for the thief's own use, the spoils of theft are generally sold for profit. Theft can be committed by insiders hiding in a facility until after hours (breakouts, unauthorized entry after hours, or tampering with inventory records. Theft by outsiders is defined as burglary or robbery.
- **Fraud**. Deceit for economic gain is fraud. Fraud is generally the use of some form of false identification that causes an element within the logistics network to give up or relinquish control of an item. In logistics, this crime is typically document fraud for authorization to release a trailer or container or fraudulent bills of lading designed to direct legitimate cargo to an alternative location for illegal sale.[1]
- **Bribery**. Giving money or substantial gifts with the intent to influence a recipient's actions constitutes bribery. The payer's intent is to gain quid pro quo from the recipient. The line between gratuities from suppliers, carriers, and third-party logistics providers and bribes is hazy and is defined by the magnitude of the exchange and the intent and response.
- **Cargo Theft**. The illegal appropriation of merchandise or materials that are being staged for movement or that are in transit defines cargo theft. Common forms of cargo theft include invasion robberies; drivers with false identities arriving to take in tow a loaded trailer; fraudulent documentation; hijacking of trucks; theft of parked rigs, trailers, or containers; piracy in port or on the high seas; and cargo acquisition by phantom ships. Phantom ships, operated by a syndicate, are general cargo vessels with repainted markings, false crew credentials, and fake registrations.

The Prevalence of Logistics Crime

Although logisticians are sensing an alarming increase in logistics-related crimes, hard data are hard to come by. This is the case for three reasons.

First, reporting systems for collecting logistics-related crime statistics are limited. For example, no mechanisms exist for aggregating data on procurement bribery, pilferage, or contract fraud.

Second, law enforcement officials have no unique category for reporting *logistics crimes*.[2] Theft of an 18-wheeler full of furs, for example, is recorded as vehicular theft, not cargo theft. After-hours theft of pallet loads of cellular phones from a manufacturer's warehouse is reported as a burglary. If the crime occurs during operating hours and the perpetrators use guns, a robbery is recorded, not a logistics crime.

Third, a propensity exists for under-reporting logistics-related crimes for reasons of insurance, publicity, and nuisance.[3] Some acts of piracy go unreported to protect the liner company from increased insurance premiums. Trucking companies do not always report trailer or container theft for fear of adverse publicity. Some victims of logistics crimes in the corporate world view the reporting and subsequent investigations as a further loss with little likelihood of a positive resolution. The crimes go unreported.[4] Nonetheless, statistical data on piracy and domestic cargo theft are becoming more available.

Piracy

Table 2 portrays summary facts on piracy. Note that reported acts have increased more than threefold since 1994.[5] The highest risk area for piracy is Southeast Asia, although Somalia and Brazil have had significant problems in their coastal waters with marauders boarding ships to plunder cargo.[6] Geographically, the problem is so severe in Somalia that ships have been advised to stay at least 50 nautical miles away from that country's coast.[7]

More acts of piracy occur in the South China Sea and in the Strait of Malacca than anywhere else in the world.[8] The South China Sea is dotted with many uninhabited islands on which pirates can hide before and after their attacks. In the Malacca Straits, there are stretches where passages are so narrow and the water so shallow that precise navigation is required. Because of this, slow moving ships are often easy targets for the pirates. Once on board, they can commandeer the entire ship or make off with selected items.

Both small groups of thieves and highly organized bands of pirates, armed with modern high-tech weapons, commit acts of piracy and intelligence concerning what the ships are carrying.[9] Piracy is also turning increasingly violent. In 1998, 51 crewmen were killed, 30 injured, and more than 400 were taken hostage.[10] In just one incident of piracy in 1999, 23 Chinese seamen were murdered.[11] The situation has become so threatening that the International Chamber of Commerce is now posting a weekly Internet report for ship operators warning of piracy attacks, their locations, and tactics.[12]

According to the International Maritime Bureau, in addition to the traditional form of piracy where malefactors board the vessels, an average of 20 phantom ship attacks occur each year. So-called phantom vessels sail under carefully faked documents and are used to steal upwards of $200M in cargo every year from East Asian docks. Most of these phantom ships are operated by groups of Chinese working out of Hong Kong, Taipei, Bangkok, and Singapore who target bulk cargoes that have a ready market—metals, minerals, timber.[13]

Cargo Theft

The predominant type of logistics crime today is cargo theft on land. This is estimated to be a thriving $10B activity in the United States.[14] For comparison purposes, $10B is 3.1 percent of the nation's annual surface transportation freight bill. Hijackings, burglarized trailers, container theft at ports, bank robbery style invasions of distribution centers, and other forms of cargo theft are growing at such alarming rates that firms, industry associations, and law enforcement joint task forces are launching a major counterattack.[15]

Several factors contribute to the recent escalation of cargo theft:

- The pervasive use of containers in domestic and international logistics has encouraged cargo theft because of the increased profit potential.[16] Simply put, stealing a container is a much more efficient form of theft than going after individual cartons or loaded pallets. Oftentimes, sophisticated criminals target containers with merchandise valued in the millions. For example, one 40-foot container full of expensive perfumes or electronics can be worth upwards of $16M.
- The huge increase in international trade has increased both the opportunity for cargo theft and created ready markets abroad where the loot can be sold for a fraction of its true value. The theft of cargo for export is rampant at our nation's seaports.
- Computers have made it much easier for insiders and hackers to gain access to shipment information that can be shared with accomplices and used to create fraudulent documentation.
- Cargo theft is a low-risk activity. These crimes receive little public attention, and until recently, authorities had not put a high priority on cargo theft. Since cargo crimes often involve multiple jurisdictions, police agencies

Reported Occurrences	Piracy by Region	Piracy by Country
1999—285	1. Southeast Asia	1. Indonesia
1998—264	2. Africa	2. Thailand
1997—229	3. Central & South America	3. Philippines
1996—205		4. Somalia
1995—127		5. Brazil
1994— 90		6. Nigeria
		7. Guatemala
		8. Ecuador

Table 2. Facts on International Policy

have not known how to investigate cargo theft. Additionally, sentencing guidelines for those convicted of this kind of crime are weak.[17]

- The electronic revolution has generated small-size, high-value merchandise that is portable with a ready market. Thieves are increasingly targeting this *value-dense* cargo.
- The profit potential of high-value cargo with a ready market has been discovered by both organized and multinational criminal elements.[18]
- Drug traffickers have expanded their operations into cargo theft. The theft of computer chips and electronics has proven to be just as lucrative as the drug trade and is far less risky. For example, an ounce of cocaine and a Pentium chip can each be fenced on a street corner for about $600.[19] Obviously, it is far safer to be stopped with a Pentium chip than with cocaine. Thieves can drive down the road with computers and not worry about transporting something illegal.
- Additionally, organized crime in the United States has joined with drug traffickers based in Latin America, Southeast Asia, and Eastern Europe to trade computer parts for drugs. These consortiums receive cocaine shipments from abroad, pay for them with stolen high-tech cargo, and ship the loot abroad where it is sold as legitimate cargo. According to cargo crime experts, the fact that microprocessors have become the drug criminals' currency of choice is the single biggest contributor to the escalation of cargo theft in the United States.[20]

Table 3 identifies the cargoes and areas most victimized by thieves. Clearly, high-value products are disproportionately targeted, particularly computer chips and electronics.[21]

At present, Los Angeles/Long Beach is considered the cargo crime capital of the United States. Southern California, New York City/New Jersey, and the Miami area are collectively known as the Bermuda Triangle of cargo crime because of the prevalence of container thefts at ports and intermodal terminals, thefts at distribution centers, stolen trailers, and truck hijackings.[22]

The situation has become so acute that some underwriters in London have recently withdrawn from insuring certain goods (computers, stereos, televisions, and designer jeans, for example) that move through these three cargo centers.[23]

In southern California, I-5 is a major crime corridor. Gangs of illegal immigrants from Columbia, Ecuador, and Peru (known to authorities as the South American Connection) rent trucks in Los Angeles, drive up to Silicon Valley in northern California to perpetrate robberies at high-tech distribution centers, and return to Los Angeles to export the loot or fence it locally.[24] Other criminals case distribution centers in the San Jose area to observe motor freight shipping patterns. They then hijack the trucks loaded with electronics and bring the contraband down I-5 where it can be exported from ports.[25]

Outside the Bermuda Crime Triangle, Memphis and Chicago are also high crime areas because they are major distribution nodes in several logistics networks.

Internationally, Russia is the country most vexed with cargo theft.[26] Cargo crimes in both Russia and Eastern Europe inhibit supply chain connections with the West because reliable distribution networks in country are difficult to establish and keep secure. Other major international cargo crime areas include South Africa, Brazil, and Mexico. The escalation in lawlessness in South Africa, where 5,773 truck hijackings alone were reported in 1998, has caused major disruptions in distribution networks.[27]

Kodak reports losing $1M a year in cargo theft in Brazil, where the biggest problem is the hijacking of trucks.[28] Other companies report similar problems in Mexico.[29] In fact, one US manufacturer has lost so many shipments of running shoes to highway bandits in Mexico that the firm now puts sneakers for the left foot in one trailer and those for the right foot in a separate rig. Another major manufacturer doing business in Mexico allows for two hijackings per month in its operating budget.[30]

Table 4 summarizes a number of salient cargo theft characteristics.

Insurance investigators and law enforcement agencies believe more than half of all cargo thefts involve employees or ex-employees.[31] When the definition of insiders is expanded to include contractors and business partners, some estimates of the proportion of thefts orchestrated by those in positions of trust are as high as 85 percent.[32]

Prior to 1997, more than 50 percent of all cargo theft occurred at distribution or transfer terminals. However, an increase in on-station vigilance and new security measures in the last few years has led to a shifting of cargo theft to intransit crimes. Intransit crimes now account for 60 percent of all cargo theft. [33]

Of the cargo crime occurring during transit, 85 percent of the losses involve motor carriers, followed by maritime, rail, and air.[34]

The FBI's Cargo Crime Task Force estimates that 40 percent of cargo thefts are carried out as an organized criminal conspiracy with the collusion of port workers, truck drivers, freight forwarders, dispatchers, and warehouse employees.[35]

The Impact of Logistics Crime

Logistics crimes impact both the emotional and physical security of the people involved in the supply chain or logistics networks, disrupt reliability in logistics services, increase insurance and transport rates, cause financial loss, contribute to higher prices, and have an economic cost on society.[36] The national shortage in truck drivers has been compounded by drivers leaving this field of employment out of fear of being hijacked. The International Maritime Bureau reports on the emotional toll piracy is taking on crew members at sea where attacks by modern *Bluebeards* are turning more violent.[37] Warehouses have become dangerous places to work with recurring instances of employees being maced, knifed, shot, and pistol-whipped.[38]

Today's supply chains are designed for high efficiency with lean inventories. Inventories for

Predominant Items Targeted by Thieves	High Cargo Crime Areas Domestically	High Cargo Crime Regions Abroad
1. Computer chips	1. Los Angeles/Long Beach area of Southern California	1. Russia
2. Electronics (for example, computers, cell phones, televisions)	2. New York City/New Jersey	2. Eastern Europe
3. Furs, sports & designer apparel	3. Miami & South Florida	3. South Africa
4. Other highly targeted cargoes: tires, tobacco, liquor, perfume, jewelry & gems	4. San Jose & the I-5 Corridor to Los Angeles	4. Brazil
	5. Memphis	5. Mexico
	6. Chicago	

Table 3. Targets of Cargo Theft

$10B Per Year Direct Cost	
Insiders help orchestrate up to 85% of cargo thefts.*	15% exclusively outsiders.
60% of crimes occur during transit.**	40% of cargo crimes occur in warehouses or transfer facilities.
85% of in-transit cargo theft involves motor carriers.	Other modes
Organized crime involved in 40% of thefts.	Small local gangs or individual criminals commit 60% of cargo crimes.
*Authoritative estimates on the involvement of insiders in cargo theft vary between 50% & 85%. **For high-tech cargo, 70% of theft occurs in transit. New security measures at electronics distribution facilities nationwide have reduced the proportion of crimes occuring onsite.	

Table 4. Domestic Cargo Theft Profile

continuous replenishment are largely in quasi warehouses on wheels or rails, afloat, or aloft. This pull-type logistics system makes cargo theft highly disruptive with plant shutdowns and customer service failures often being the end result.

In economic terms, logistics crimes in all their dimensions have an obvious impact. Pilferage increases costs. Bribery distorts and suboptimizes a firm's resource allocation decisions. Theft in the electronics industry is estimated to add $150 to the price of a personal computer.[39] Stolen products may reappear on the market at a low price and compete with goods that have moved through legitimate channels. Insurers are increasing deductibles (in many cases from $50K to $500K per incident), raising premiums, and in some cases, refusing to insure certain cargoes in specific transportation lanes.

In terms of cost to society, the RAND Corporation determined cargo theft has multiple costs. In addition to the direct loss associated with the crime, indirect costs of reporting and internal investigations, enhanced security measures, police investigations, lost and displaced sales, reduced profits to the transportation industry, and increased prices to consumers can be a sixfold factor.[40]

The dollar magnitude of pilferage is difficult to assess. Risk management experts report that pilferage is pervasive, operating as a cancerous growth and, for most firms, a larger problem than theft. John Case, a leading security management consultant, states that as a national average for industrial and retail firms, three out of ten employees pilfer and the cost of pilferage far exceeds the cost of theft.[41]

Collective Approaches to the Problem

Government and law enforcement agencies, industry associations, and professional groups are taking concerted actions to deal with the crisis in logistics crime. These include the following actions.

- The National Association of Purchasing Management has formulated guidelines and training materials to deal with gratuities and the potential for bribery in procurement. Logistics management consultants have also developed new expertise in crime prevention and have substantially increased their services in the areas of loss prevention strategies, physical facility design for security, and new crime deterrent technologies.
- Twenty-five high-technology companies have banded together to organize the Technology Asset Protection Association to issue security guidelines on international cargo handling and strategies for evaluating security procedures of carriers.[42]
- The American Trucking Association, a strong voice for elevating the status of cargo theft to a federal crime, recently established a national cargo theft information and prevention service. This capability allows trucking firms and law enforcement officials use a secure Internet to share details on cargo crimes.[43]
- The Western States Cargo Theft Association, a law enforcement and industry partnership dedicated to eradication of cargo theft and hijacking in California, now communicates information on criminal methods

and appropriate defensive strategies. Their Internet site posts hefty rewards for tips leading to the recovery of specific heists.[44]

- The National Cargo Security Council was formed in 1997 as a coalition of transportation providers and government agencies for developing *best practices* to foil cargo crime.[45]
- In early 1999, President Clinton set up the Interagency Commission on Crime and Security at US seaports. This commission—involving senior officials from Treasury, Justice, and Transportation—has already recommended stiffer penalties to deter cargo theft at port cities and may recommend mandatory licensing of all dock workers.[46]
- On 9 January 1999, Senator Thomas A. Daschle (D-South Dakota) introduced Senate Bill 9 (Subtitle H, *Deterring Cargo Theft*). This pending legislation, cosponsored by 17 Senators, expands the definition of cargo crime under federal jurisdiction, increases federal sentencing guidelines for cargo theft, and establishes a national database on cargo theft. The bill will also require the Attorney General to submit an annual report to Congress, evaluating law enforcement activity relating to the investigation and prosecution of cargo theft.[47]

Suggestions for Logistics Managers

Examining an organization's exposure to logistics-related crimes suggests that managers must deal with the prospects of onsite crimes committed by both insiders and outsiders. In addition, managers must control their risks incident to offsite crimes when their products are in the custody of a third party or being transported by private fleet.

Written and Communicated Policies and Procedures

Managing an operation's exposure to logistics crime begins by developing clear policies and a loss prevention plan. The process requires engaging and coordinating with logistics partners (contracted operations and transportation companies, for example) and may require the retention of a loss prevention consultant.[48]

A firm must articulate to its employees and partners its expectations concerning honesty and its policies and procedures relating to crime prevention. Further, it must communicate to all trusted agents the impact that logistics crime can have on their common well being.

A loss prevention plan will incorporate written policies and procedures and directives for physical security measures, employee screening, document and communications security, evaluation of transportation providers, driver identification and control, and employee and work management.

Loss prevention campaigns with prominently displayed posters and tips bulletins—coupled with recurring training sessions to communicate corporate policies on accepting gratuities, no-exception accountability records, safeguarding the confidentiality of documents and computer records, controlled access, need-to-know communication restrictions, reporting suspicious behavior, challenging unknown individuals, and using an anonymous tip line—form the basis of an internalized loss prevention plan. Employees must understand the organization's top-to-bottom commitment to high ethical standards and loss prevention.

Physical Security

The ultimate in physical security begins with a building design that divides the facility into cells protected by locked doors that can only be opened by electronic code.[49] Such a system, coupled with controlled access from the outside and electronic tracking of all movement of people and inventory within, makes invasion robberies, thefts, breakouts, and pilferage almost impossible.

The full range of physical security measures includes fences, security guards who do random and double-back patrolling, ample interior and exterior lighting, closed-circuit television cameras, a uniform identification and sign-in system, employee parking lots away from inventory storage areas and outside fences, intrusive detection alarms (infrared, acoustic, or mechanical), good housekeeping, separation of shipping and receiving areas, and all dock doors closed when not actively receiving. Other measures include limiting the number of exits employees can use and rotating security guard assignments to discourage fraternization with employees who may turn out to be dishonest.

Employee Screening

The majority of logistics crimes can be traced to insiders, including reconnaissance done by temporary employees, suppliers, customers, and contractors.[50] As a result, a comprehensive loss prevention plan must involve criminal and credit checks on new employees, independent contractors, and other insiders. Such screenings require careful adherence to law.[51]

Document and Communications Security

Firms should insist on no-exception accountability. No cargo should move without a document (or a computer record with bar code and scanner tracking), even if it is being shifted within the warehouse itself. Bills of lading and packing lists must be controlled. Employee access to electronic data interchange (EDI). (Dishonest employees use access codes belonging to coworkers to trace shipments for a robbery or to deliberately misdirect a shipment to set up a theft.) Limit discussions on inventories and shipments to a need-to-know basis. Drivers must be cautioned not to talk about the loads they carry, both on the CB and at truck stops. Thieves must not be guided to the merchandise with labels; nondescriptive packaging must be used and logos removed from containers.

Evaluation of Transportation Providers

Because the majority of cargo theft occurs offsite, the evaluation of security practices of the transportation providers and freight forwarders is crucial.[52] Security conscious third parties will incorporate such practices as:

- Employee background checks.
- Instructing drivers to be mum on cargoes and routes.
- Parking the rear of the truck against a wall or never leaving a truck unattended.
- Advanced locking mechanisms on the rear of cargo trucks, including alarmed devices, controlled access to and within freight terminals, transponders, and the Global Positioning Satellite system for multimodal and worldwide tracking of freight.
- Use of secure containers with heavy duty barrier seals that are drill and pick resistant.
- EDI transmittal of documentation to limit ability to change bills of lading and so on.[53]

One of the best ways to assess the security practices of a carrier is to insist on seeing evidence that the carrier's insurance company has audited and approved the plan.

With respect to carrier liability and insurance, shippers must understand limitations to which they may be subjected. For example, a carrier may limit its liability to $250K per trailer or container even though the value of the contents far exceeds this amount. Insurance is typically not available for motor freight into Mexico.

With the high levels of cargo theft today, insurance companies have substantially raised the deductibles carriers must pay (particularly for high-value cargo).[54] Shippers need to evaluate the financial posture of prospective carriers to ensure carriers can meet these hefty deductibles. It is particularly important to assess the financial position of carriers who are self-insured.

For international shipments, shippers must be alert to the fact that carriers are being denied insurance protection for some high-risk ports (south Florida, for example).[55] For ocean freight (particularly freight moving through areas of high piracy), the shipper must confirm the freight is protected by an *all risks* policy.

Driver Identification and Control

Firms should demand photo identification and authorizing documentation from all outside drivers. Providing a driver waiting room or establishing a line in the warehouse that drivers are not allowed to cross is also prudent.

Employee and Work Management

Security consultants report that compensation levels directly affect theft rates, since employees view pilferage as a tax-free bonus for being underpaid.[56] Mangers must not only promote a sense of mission efficiency and cost objectives among employees but also ensure that pay is equitable.

Managers must also design work assignments in procurement, warehousing, and shipping to ensure separation of duties. Additionally, buyers, traffic managers, inventory managers, and other key players should occasionally be rotated to other duty areas or positions. Separation and rotation of duties reduces the ability of one individual to perpetrate a logistics crime.

Employees must be trained in the *need-to-know* communications philosophy on the job and instructed in not talking about their company's affairs and procedures in public.[57]

Employers should provide a problem-solving forum or an employee assistance program for associates with financial difficulties, substance abuse problems, or even mental health difficulties. Such a program can defuse the propensity for insiders to perpetrate logistics crimes.[58]

Finally, employees must be made formally accountable for losses. This is best done through training and by having each employee sign a form that states clearly all company policies relating to honesty and integrity, including causes for dismissal.

Conclusion

Logistics managers need to become aware of the growing risks of becoming a victim of logistics crime. These crimes can occur onsite (bribery, pilferage, and records tampering) or offsite (container theft, robbery, and hijackings). Further, most logistics-related crimes of both categories involve insiders.

The most burgeoning problems are cargo theft (domestically and internationally) and piracy on the high seas. In dollar magnitude of loss, however, the most significant problem may be pilferage. Perhaps the most pernicious problem is bribery of decision makers because this crime can go undetected for long periods and distorts critical resource allocation decisions.

The trends in cargo crime are particularly serious: escalating rates, growing involvement of drug traffickers and organized crime, increasing violence, and more sophisticated executions involving insiders and fraud tied to the computerization of freight handling.

The FBI recently reported, "The theft of cargo has become so widespread that it constitutes a serious threat to the flow of commerce in the United States."[59]

The growth in logistics crime in the last decade has gone from random and insignificant to a serious problem that is increasing costs to logistics players, consumers, and society at large.

Efficiency in supplier choice and reliable inbound deliveries and efficiency and reliability in outbound distribution are at the heart of modern economic activity. Logistics crimes not only are expensive but also disrupt the reliability and efficiency that form the backbone of modern logistics networks.

Leading-edge logistics managers of today must modify their practices and introduce new controls to reduce the risk of being victimized by logistics crimes.

Notes

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8. *Ibid*. *73*.
9. "We're beginning to see more ships being attacked on the basis of the types of cargo that they are carrying. Somehow they are acquiring information from industry sources." Thomas J. Timlen of the Baltic and International Maritime Council in Denmark, an organization that tracks worldwide piracy statistics, as quoted in "Piracy Modern Style," *American Shipper*, Mar 97, 72.
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15. Toby B. Gooley, "Hands Off! Organized Gangs of Thieves Want Your Freight," *Logistics Management and Distribution Report*, 1 Feb 99, 7-9.
16. When first introduced, containers greatly reduced pilferage and theft because containers secured freight. However, in recent years, criminals with the right equipment see a lucrative new target, and new and more sophisticated patterns of theft have developed. See Intermodal Cargo Transportation: Industry Best Security Practices, 68.
17. "Hands Off! Organized Gangs of Thieves Want Your Freight," 9.
18. "Highway Robbery," *Silicon Valley News*, 14 Feb 99.
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22. "South Florida Becoming 'Casablanca' for Cargo Theft," *Naples Daily News*, 3 Jan *98*.

Logistics Infrastructure
and Expeditionary Airpower

We need to continue the transition from a threat-based Cold War garrison force, focused on containment, to a capabilities-based expeditionary force focused on responsiveness.

—General Michael Ryan, Chief of Staff, USAF

In a sense, the expeditionary use of airpower is not something new. In fact, one might argue that expeditionary airpower was present in the skies over Mexico in 1916, as the nascent Air Service chased Pancho Villa. Further, one could argue that airpower was expeditionary in each of the world wars and Korea as well. However, the force being molded today differs drastically from these historical predecessors. Rather than being reactive, airpower must now be proactive to meet the needs of a rapidly changing world. Today's definition of expeditionary airpower means a rapid response force that is light, lean, and tailored to mission needs. That being said, how does the Air Force become the expeditionary force we need today? What are the challenges, opportunities, and initiatives that need examination? And perhaps more important, how do existing logistics concepts and principles need to change to support expeditionary airpower.

To get close to the required execution order plus 48-hour deadline for placing the first bombs on target, air expeditionary wings (AEW) must deploy to category-1 bases. Further, given that a flight halfway around the world takes approximately 20 hours, pushing the time line below 48 hours will require either having people deployed or materiel at an advanced state of preparation at the forward operating location (FOL) or both.

Equipping numerous category-1 FOLs from scratch would be very expensive. Although much of the cost for current processes might well be sunk, maintenance and storage costs will still have to be paid. Anecdotal accounts of current (nonurgent) deployments to Southwest Asia indicate current maintenance arrangements there do not keep equipment ready for immediate use, suggesting that these costs might be larger than are paid now. Further, future munitions and improved support equipment not already in the inventory would have to be bought for the FOLs. Therefore, significant attention should be given to resourcing a number of FOLs in each category in order to provide a range of employment time lines for operational use. Within different regions, different employment time lines may be required. Not all regions may need to have category-1 FOLs or necessarily the same number of category-1 FOLs. The identification of various categories of FOLs throughout the world is important for supporting not only aerospace expeditionary force (AEF) operations but also major theater war operations. Attention should be given to pursuing host nation support agreements to the extent possible to offset costs and lift requirements.

Forward support locations (FSL) provide a compromise in cost between prepositioning at FOLs and deploying everything from the continental United States (CONUS).[1] They have little effect on the time line for initial capability, but they do avoid the necessity of having a tanker air bridge for the extra strategic lift from CONUS. Further, the strategic lift then becomes available for use in deploying additional combat units.

Category-2 bases represent another compromise between cost and time line. However, deploying to a category-2 base takes about 3.3 days (airlift flow and unloading airlift aircraft) and 2-3 days to set up munitions and fuels storage. Increased ramp space would not significantly speed up the deployment process. Plus, the agreements for vehicles, medical facilities, and so forth would probably require some time to finalize unless very complete arrangements had been completed well in advance.

Category-3 bases are not useful as FOLs for very quick crisis response given the time required for airlift offload operations and to set up the support processes. However, this is a function of the current processes, and the time line estimated here is for a stressing combat scenario. A less stressing combat scenario or a humanitarian operation might well be feasible from such a category-3 FOL within the 48-hour time line.

The concept of the Expeditionary Aerospace Force has significant implications for two Air Force core competencies: Agile Combat Support and Global Mobility. Rapid deployment places an emphasis on reducing the logistics support that must be deployed, but the current force structure and current logistics processes mandate a forward logistics structure that prepositions equipment and support packages in order to meet potential operating tempos. FSLs, logistics command and control, and very responsive resupply can also reduce the amount of materiel and people that need to be deployed to FOLs. New technologies and continuous process refinement can also reduce the deployment footprint over a period of years.

The deployment footprint could be reduced in three major areas: munitions, ground equipment, and shelters. Continued research is needed to reduce the weight and bulkiness of munitions and support equipment.[3] The weight and volume of the current bare-base shelter package could be eliminated via commercial alternatives, some of which are being explored.

The issues concerning FOLs, FSLs, and their location and equipping require some planning decisions be made centrally from a global and strategic perspective. Those decisions should be revisited on a regular basis as the global political situation changes and as technology offers new options.[3]

RAND/Air Force Logistics Management Agency research argues for three major policy changes. First, storage and maintenance policies for prepositioned equipment should be carefully formulated and rigorously enforced, especially if third-party contractors are used to do some or all of the work. Second, host nation support should be considered in planning and execution. How much support can the Air Force expect from allies and how does this change US support requirements? Finally, the other Services could use support concepts similar to the FSL/FOL mixes.

Global Infrastructure

There are five basic components of the global infrastructure. These components are FOLs, FSLs, CONUS support locations, responsive resupply/transport system, and a logistics command and control system.

FOLs are the locations from which aircraft conduct their operations or missions. FOLs are divided into three categories based on their infrastructure and our derived time lines:[2]

- A **category-3** FOL is a *bare base*. It meets only the minimum requirements for operation (runway, fuel, and water) of a small fighter package. Such a base would take almost a week (144 hours) to prepare to support AEW high-sortie generation rates.
- A **category-2** FOL has the same support facilities as a category-3 base plus prepared space for fuel storage facilities, a fuel distribution system, general-purpose vehicles (host nation support or for rent), and basic shelter. It may take up to 96 hours before a category-2 base could support AEW high-sortie generation rates.
- A **category-1** FOL has all of the attributes of a category-2 base plus an aircraft arresting system and munitions buildup and storage sites already set up and 3 days' worth of prepositioned munitions. Such a base could be ready within 48 hours of the execution order to support high AEW sortie generation requirements.

Notes

1. Much of the difference in recurring costs occurs because of the expense of running exercises from CONUS and the form of the exercises.
2. Planners at US Air Forces in Europe have independently developed a similar classification for bases in their theater. HQ USAF/Installations and Logistics-Maintenance has also proposed a division of bases for its planning analyses.
3. The AEF Battlelab at Mountain Home AFB is overseeing development of a combined compressor/air-conditioner for flight-line use, and the Aerospace Ground Equipment Working Group is investigating items such as collapsible maintenance stands. The Air Force Research Laboratory at Wright-Patterson AFB is investigating modular support systems for both legacy and future weapons systems.

Excerpted and edited from "A Global Infrastructure to Support EAF," *Expeditionary Logistics 2000: Issues and Strategy for the New Millennium*, July 2000, Lionel A. Galway, Robert S. Tripp, C. Chris Fair, Timothy L. Ramey, John G. Drew.

general theory

Growing World of Logistics

of logistics practices

Stephen Hays Russell, PhD

Clearly, logistics as a concept and a practice has evolved over the years and is a discipline that is now practiced in different ways and contexts. Logistics means different things to different people. Even professionals in the field differ as to what logistics actually means.

The underlying general theory of logistics practices as developed here identifies the roots of logistics as being capabilities, protocols, and responsive service. Indeed, all logistics is the science of developing and managing the capabilities and protocols that are responsive to customer-driven service requirements.

The Term Logistics

The English word logistics appears to have been derived from both the Greek word *logistikos* and the French word *logistique*. *Logistikos* is rooted in the concept of logic and means skilled in calculation. *Logistique* is probably influenced by the French *loger,* meaning to quarter (or lodge) soldiers. Hence, the combination of logic, calculation, and quartering soldiers appears to have yielded the word.

The term logistics entered military terminology in 18th century Europe. The *maréchal des logis* was the administrative officer responsible for encamping and quartering troops. As warfare became more advanced with an increasing variety of weapons and ammunition, the *maréchal des logis'* duties were expanded to include the stocking of supply depots.[1]

The term was first employed in a formal sense in the American lexicon in the late 19th century when Rear Admiral Alfred T. Mahan, American naval strategist, introduced the word logistics into the US Navy.[2] The term received a written definition in 1905 as that *branch of the art of war pertaining to the movement and supply of armies*.[3] But it was not until World War II that the term began to be used pervasively to describe the support of military forces and their equipment.

Beginning in the 1960s, logistical support of weapon systems became an integral part of the planning and design stages of these systems. During this period, logistics as practiced in the military grew into engineering (or systems) logistics, with an emphasis on engineering issues, calculating initial support requirements, and programming resources to keep a system operational after introduction. Engineering logistics stresses reliability and maintainability engineering, configuration management, provisioning and continuing supply support, repair level analysis, technical manuals development, training, data and records management, and life-cycle cost management. In this sense of the word, logistics is largely a modeling and quantitative discipline.

The term logistics migrated to the business sector in the 1960s as academicians in marketing saw potential in applying the principles of military logistics to physical distribution of consumer goods.[4] Business logistics evolved into a dichotomy of inbound logistics (materials management or physical supply) to support production, where the plant is the customer, and outbound logistics (physical distribution of product) to support external customers.

Most recently, the business community began viewing logistics as a component of a larger evolving concept, supply chain management (SCM). SCM is a linking of all firms up and down the supply chain (from ultimate material sources to ultimate customers) in a collaborative and seamless network.[5]

Beginning in the 1970s, the term logistics crept into the lexicon of the common culture. The word is now being used with regard to the supply support of activities from church picnics to the Olympics. During the US famine relief efforts in Bangladesh in 1974 and in Somalia in 1992 and 1993, logistics was applied to the distribution of food.[6] In recent years, the popular press has written of the logistics of waging a Presidential campaign and the logistics challenges of providing relief to victims of the floods in Honduras in 1998 and of recent hurricanes.

Definitions of Logistics

Clearly, logistics as a concept and a practice has evolved over the years and is a discipline that is now practiced in different ways and contexts. Logistics means different things to different people. Even professionals in the field differ as to what logistics actually means.

Table 1 presents a variety of definitions of logistics. To some, logistics is managing the flow and stock of materials. To others, it is a customer support activity, a planning and engineering mechanism, or a science of calculating requirements and promoting operational capabilities. The dictionary treats logistics as purely a branch of military science. The Council of Logistics Management defines logistics purely in a product distribution context. The common culture of today views logistics as the underlying details of making something happen.

Perhaps the most fundamental definition of logistics is the classical definition: getting the right product, to the right customer, in the right quantity, in the right condition, at the right place, at the right time, and at the right cost.[7]

All these definitions, explicitly or implicitly, have in common the concept of integrating many activities toward supporting an organizational objective. Further, all have, expressed or implied, a sense of meeting the material, system, or process needs of a customer.

A New Logistics Paradigm

A consideration of the various practices that, taken together, define logistics suggests that logistics is a branch of management that is practiced in four subdisciplines:

- **Military or engineering logistics.** The design of supportability into weapon systems and other capital assets, assessment of technical requirements for training and maintenance, computation of post-sale support requirements, and integration of all aspects of support for the operational capability of military forces and their equipment.
- **Business logistics**. The planning and management of supply sources, inventories, transportation, distribution networks, and related activities and supporting information to meet customer requirements.
- **Event logistics.** The network of activities that brings together the resources required for an event to take place.[9] Event logistics is characterized by deployment of resources (forward logistics) and withdrawal of resources (reverse logistics) according to the events schedule, significant contingency planning, and the powerful presence of the logistics function in the events management team.[10] Examples of event logistics include the detailed planning and support requirements necessary to execute a circus, a rock concert, a scout encampment, news coverage of the O. J. Simpson murder trial (more than 500 reporters and their satellite-linked vans and other equipment), the Olympic Games, and a Presidential trip.
- **Process logistics.** The acquisition, scheduling, and management of human and material resources to support a service. Process logistics typically involves the coordinated employment of facilities, capital assets, and service personnel to create the framework for a process to occur. Examples include bus transportation of school children, mail delivery, drug smuggling, Red

Source	Definition	Source	Definition
Short	Management of materials in motion and at rest.	Utility	Providing time and place utility of materials and products in support of organization objectives.
Classical	Getting the right product, to the right customer, in the right quantity, in the right condition, at the right place, at the right time, and at the right cost. (Called the Seven Rs of Logistics.)	Council of Logistics Management	"That part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from point of origin to point of consumption in order to meet customers' requirements."****
Dictionary	The branch of military science having to do with procuring, maintaining, and transporting materiel, personnel, and facilities.	Component	Supply management for the plant (inbound logistics) and distribution management for the firm's customers (outbound logistics) or material support of manufacturing and product support of marketing operations.
International Society of Logistics	"The art and science of management, engineering, and technical activities concerned with requirements, design, and supplying and maintaining resources to support objectives, plans, and operations."*	Functional	Materials requirements determination, purchasing, transportation, inventory management, ware-housing, materials handling, industrial packaging, facility location analysis, distribution, return goods handling, information management, customer service, and all other activities concerned with supporting the internal customer (manufacturing) with materials and the external customer (retail stores) with product.
Famous Nebulous	World War II Chief of US Naval Operations Admiral Ernest H. King: "I don't know what the hell this logistics is that (Army Chief of Staff General George C.) Marshall is always taking about, but I want some of it."**	Common Culture	Handling the details of an activity.
Biblical	"I have heard of you . . . that light and understanding and excellent wisdom are found in you . . . I have heard that you give interpretations and solve problems . . . you shall be clothed with purple and have a chain of gold about your neck . . . ." (Daniel 5:14;16)***	*Barbara King, director of administration, International Society of Logistics, 17 Nov 00. **US General Accounting Office, *Welcome to the Logistics and Communications Division*, Washington DC: Government Printing Office, 1974, 2. ***Ronald H. Ballou, Business Logistics Management, 4th ed, Saddle River, New Jersey: Prentice Hall, 1999, title page. ****Council of Logistics Management, [Online] Available: www.clm1.org, 8 Nov 00.	

Table 1. Definitions of the Discipline of Logistics

Cross relief operations, and operation of a multidimensional orthodontics office (scheduling stations, personnel, and parallel and sequential workflow for efficient and effective service).

Supply chain management is the collaborative integration of all logistics processes by all players in a chain, from original suppliers through end users. The process is a customer-driven system involving the sharing of information, risks, and assets among partners to achieve an integrated, seamless, responsive distribution system. SCM literature views business logistics as a component of supply chain management. Supply chain management is differentiated from logistics in that it involves all partners (suppliers, carriers, other distribution channel participants, and customers) up and down the supply chain and, hence, is more than the internal integration of logistics activities within a firm.[8] The key concepts of SCM are pull system, customer-driven, strategic alliances, shared data, and system (as opposed to firm) optimization. However, SCM can be viewed as fully integrated logistics, meaning not only the integration of all logistics activities in a firm but also the comprehensive backward and forward integration of all logistics processes in a channel. SCM, then, is a new term for integrated business logistics (albeit a larger view of integrated).

A General Theory of Logistics Practices

Interestingly, the dictionary gives only one definition of logistics (the military context of the term). Today, however, the various practices that are considered logistics can be classified into four types. The question arises whether future dictionaries should modernize their perspective of logistics in practice and offer multiple definitions of the term or whether there is some common platform or general theory of logistics from which all logistics practices spring.

A careful analysis of the four branches of logistical practice, as presented, suggests that logistics is customer service, relates to developing capabilities and managing activities that focus on meeting support needs, and involves logic and calculations. The proposition of this research is that there is, indeed, a general theory of logistics practice:

> Logistics is the science of developing and managing the capabilities and protocols that are responsive to customer-driven service requirements.[11]

The richness of this construct of logistics is suggested by focusing on the component words and noticing their relevance to all four types of logistics:

- **Science**: logic, mathematics, statistics, models, computers, information technology, algorithms, engineering principles, systems concept, cost analysis, optimization techniques, tradeoffs, and sensitivity analysis
- **Developing**: organizing, formulating objectives, designing, team effort, partnering, contracting, creating, evolving, augmenting, achieving
- **Managing:** planning, negotiating, programming, implementing, communicating, deploying, measuring, controlling, improving
- **Capabilities:** physical assets, programs, human capital, historical data, forecasting, experience, real-time information, software, hardware, strategic alliances, access, capacity, competence
- **Protocols:** operational plans, methods, logic networks, data systems, strategies, human decision making, techniques, outsourcing, contingency plans
- **Responsive:** anticipate needs, meet needs, exceed needs, fulfill objectives, minimize costs, react constructively, respond to change, thwart failure, optimize performance, and differentiate performance
- **Customer-driven:** pinnacle of direction and control, source of authority, place of ultimate measure, meeting expectations, origin of pull requirements, reason for being, beneficiary of achievement
- **Service requirements:** meeting objectives, quality, excellence, operational, satisfied, value-added, efficient, responsive, available, damage-free, time-and-place utility, life-cycle management.

Table 2 portrays the general theory of logistics practices as presented in this article for all four logistics subdisciplines. Examples of the capabilities, protocols, and services are illustrated.

Consider, for example, a deployed fighter wing. The customer who drives the requirements and to whom the logistics system must respond is the wing or theater commander. The military logistics organization has in place, as examples, sustainability and airlift capabilities that are executed with specific protocols (logistics plans, supply support, materiel contracts, and industrial mobilization). Some of the services the customer-responsive logistics system provides are fuel, rations, spare parts, and ordnance.

In engineering logistics, a using command (for example, Air Combat Command) specifies readiness and support requirements for new aircraft. The logistics community, with such capabilities as design for supportability and the Integrated Logistics System, uses established protocols (reliability and maintainability engineering, logistics models, repair level analysis, and so forth) to give the customer the product-support services required.

For inbound business logistics, a firm like Proctor and Gamble will specify logistics standards for efficient and responsive support of its production operations. The firm's internal logistics operations will have established capabilities such as a network of world-class suppliers, transportation partners, and a continuous flow capability. These capabilities are realized with the employment of supporting protocols (demand forecasting, materials requirements planning, dedicated contract carriage, and so forth) to provide an inbound logistics system that ensures availability of production materials with minimal investment in inventory.

In outbound logistics, Proctor and Gamble's customer (Wal-Mart, for example) is in the driver's seat, imposing such service standards on Proctor and Gamble's logistics system as a 95-percent order fill rate, 5-day order cycle, and damage-free delivery. Proctor and Gamble will have in place customer-responsive capabilities such as regional distribution centers, information and computer technologies, and shipment tracking. These capabilities are built upon protocols such as a point-of-sale replenishment system, vendor-managed inventory, advanced packaging methods, and electronic commerce capabilities that ensure the customer's logistics standards are satisfied.

Similar relationships exist in event logistics and process logistics. Customers dictate standards of service. Logistics systems exercise protocols within their framework of response capabilities.

These illustrations reinforce the notion that there are root concepts or processes in logistics, a general theory of logistics practices that encompasses all logistics.

Summary

The new paradigm introduced in this article demonstrates that logistics is practiced in four subdisciplines: military, business, event, and process.

Logistics is logic, wisdom, calculations, models, networks, inventories, transportation, distribution, customer service, time-and-place utility, storage, flow, details, optimization, and collaborating. It is a set of support activities. It is being responsive to customer requirements for materials, goods, and services.

The underlying general theory of logistics practices as developed here identifies the roots of logistics as being capabilities, protocols, and responsive service. Indeed, all logistics is the science of developing and managing the capabilities and protocols that are responsive to customer-driven service requirements.

Logistics	Capabilities	Protocols	Services	C
Military	Airlift Sealift Operational readiness Sustainability	Logistics plans Provisioning War reserve spare kits Containerization Supply support Maintenance plans Materiel and service contracts Industrial mobilization	Fuel Rations Spare parts Maintenance Ordnance Mail Medical supplies	Figl
Engineering	Design for supportability Integrated logistics support Tradeoffs Life-cycle cost management	Reliability engineering Maintainability engineering Modeling Configuration management Repair-level analysis Data management Life-cycle costing Training engineering Logistic support analysis	Operational readiness Sustainability Product support	Air
Business (Inbound)	Continuous flow World-class suppliers Shipment tracking Transportation network Inventory management Automated materials handling	Demand forecasting Material requirements planning or just-in-time system Strategic purchasing Global positioning satellite system Dedicated contract carriage Warehouse management systems Automated storage and retrieval systems Bar codes	In stock Minimal inventory Reliable deliveries Warehouse accuracy Responsive to requirements	Mar
(Outbound)	Customer-driven Computer systems Regional distribution centers Value-added services Shipment tracking Carrier management Information accuracy	Point-of-sale technology replenishment system E-commerce Electronic data interchange Merchandise labeling/assorting WWW site Private fleet Advanced packaging Pick-to-light system Vendor-managed inventory Collaborative planning, fore-casting, and replenishment	95% order fill rate 5-day order cycle 99% picking accuracy Damage-free delivery Liberal return policy 96% on-time delivery Customer satisfaction	Ret
Event	Pre-event planning and staging Support Cleanup (asset withdrawal)	Logistician authority Strategic plan Tactical plans Procurement system Transportation network Requirements algorithms Command post Receiving and storage Facilities plans Service contracts Contingency plans Packing and crating Reverse Logistics	Equipment in place Supplies in place Facility operational Inventory management and issue Asset control and protection Flexible response Participant support services Spectator support services Media support services Redeployment after event	Oly
Process	Bus transportation	Asset procurement Vehicle maintenance Route design Time schedules Fuel contracts Safety plans	Transportation to school	Sch

Table 2. Example Elements of the General Theory of Logistics Practices

Notes

1. John I. Alger, *Definitions and Doctrine of the Military Art, Past and Present*, Wayne, New Jersey: Avery Publishing Group, Inc, 1985, 56.
2. Silverio L. Ostrowski, "Generic Strategies for Logistics in the Military and Commercial Sectors," unpublished doctoral dissertation, Cranfield University School of Management, Bedfordshire, England, 1996, 1.
3. Chauncey B. Baker, *Transportation of Troops and Material*, Kansas City, Missouri: Hudson Publishing, 1905, 125.
4. John C, Langley, Jr, "The Evolution of the Logistics Concept," *Journal of Business Logistics*, Sep 86, 1-12.
5. J. Blaser and B. Scott Westbrook, 'The Supply Chain Revolution," *The Performance Advantage*, Vol 5, No 1, Jan 95, 43-49.
6. "Getting It There," *Logistics Handbook for Relief and Development*, World Vision International Headquarters, Monrovia, California, 1987.
7. R. D. Shapiro and J. L. Heskett, *Logistics Strategy: Cases and Concepts*, St Paul, Minnesota: West Publishing, 1985, 4.
8. Martha C. Cooper, Douglas M. Lambert, and Janus D. Pagh, "Supply Chain Management: More Than a New Name for Logistics," *The International Journal of Logistics Management*, Vol 8, No 1, 1997, 1-14.
9. Event logistics has been defined as "the activities between the event and chaos." See "The Battle of Atlanta: The 1996 Summer Olympics," *Distribution Magazine*, Mar 96, 24.
10. Interview by author with Craig Williams, director of logistics for the Atlanta 1996 Summer Olympics, Mar 98. "No one says no to an event logistician. Conducting the Olympics is logistics."
11. Frank W. Davis and Karl Manrodt, "The Evolution to Service Response Logistics," *International Journal of Physical Distribution and Logistics Management*, Vol 22, No 9, 1992, 3-10.

Wartime equilibrium refers to that short period at the peak between rearmamental instability and demobilizational instability when the war economy has been fully developed and crisis has been accepted as the norm. The other equilibrium is peacetime when money rather than time dominates.

—Dr Robin Higham

Logistics
and Technology

Technology (to include technological change and technological innovation) as a subject covers a lot of ground and often enjoins heated debate. It has proven to be one of the major tools for dealing with problems, more so in the last century than at any other time in history. However, critics of technology argue that it often causes as many problems as it solves and the new problems are often far worse than the old ones. Further, they question its validity as a major tool for solving complex problems rooted in ethical, philosophical, political, or other nontechnical areas.[1] These are certainly, by no means, all the criticisms of technology, but they serve to frame the basic objections. The counter argument to these criticisms would answer that technology is not unique in creating new and, often, more difficult problems while solving old ones. Very much the same criticism could be aimed at all approaches to problem solving. No problem-solving approach yields simple, final answers to the basic problems of humankind.[2] One could even argue that philosophical and other nontechnical approaches have done little when measured against the same standards; they fail just as abjectly as technology.[3] Further, the fact that technological solutions are inappropriate in certain situations does not mean that technology is always unsuited to problem resolution. Technology cannot be viewed as a separate entity within either the military or society in general. This illusion of discreteness simply does not exist. It is and will remain an integral part of both. The real issue is to recognize that technology is a tool with limitations, and these limitations should be considered in reacting to particular situations. Technology does not offer a *silver bullet* for all situations.

A variety of human and cultural factors still impedes full-scale adoption of many new technologies—complexity and difficulty in their use, loss of control, changes in fundamental power relationships, uselessness of old skills, and changes in work relationships. Change and instruments of change, as apparent as they seem once implemented, often elude understanding before they enter the mainstream.[4] As an example, Chester Carlson, the inventor of the photocopy machine (often referred to as the Xerox machine) was told by business that his invention was unnecessary because libraries and carbon paper already filled the need. This was a technology that drastically altered the way people approached information, yet finding interested businesses and investors in the beginning proved elusive.

Notes

1. John E. Jordan, Jr, and Thomas C. Lobenstein, "Technology Overview" from *Low-Intensity Conflict and Modern Technology*, ed. Lt Col David J. Dean, Maxwell AFB, Alabama: Air University Press, 1986, 105.
2. *Ibid*.
3. Jordan and Lobenstein, 106.
4. Norma R. Klein, "Technology Trends and Logistics: An Interrelational Approach to Tomorrow," *Air Force Journal of Logistics*, Vol XIII, No 2, 36.

technology and war

. . . technology and war operate on a logic which is not only different but actually opposed, nothing is less conducive to victory in war than to wage it on technological principles—an approach which, in the name of operations research, systems analysis or, cost/benefit calculation (or obtaining the greatest bang for the buck), treats war merely as an extension of technology. This is not to say . . . that a country that wishes to retain its military power can in any way afford to neglect technology and the methods that are most appropriate for thinking about it. It does mean, however, that the problem of making technology serve the goals of war is more complex than it is commonly thought to be. The key is that efficiency, far from being simply conducive to effectiveness, can act as the opposite. Hence—and this is a point which cannot be overemphasized—the successful use of technology in war very often means that there is a price to be paid in terms of deliberately *diminishing* efficiency.

Since technology and war operate on a logic, which is not only different but actually opposed, the very concept of "technological superiority" is somewhat misleading when applied in the context of war. It is not the technical sophistication of the Swiss pike that defeated the Burgundian knights, but rather the way it meshed with the weapons used by the knights at Laupen, Sempach, and Granson. It was not the intrinsic superiority of the longbow that won the Battle of Crécy, but rather the way which it interacted with the equipment employed by the French on that day and at that place. Using technology to acquire greater range, firepower, greater mobility, greater protection, greater whatever, is very important and may be critical. Ultimately, however, it is less critical and less important than achieving a close *fit* between one's own technology and that which is fielded by the enemy. The best tactics, it is said, are the so-called *Flaechenund Luecken* (solids and gaps) methods which, although they received their current name from the Germans, are as old as history and are based on bypassing the enemy's strengths while exploiting the weaknesses in between. Similarly, the best military technology is not that which is "superior" in some absolute sense. Rather, it is that which "masks" or neutralizes the other side's strengths, even as it exploits his weaknesses.

The common habit of referring to technology in terms of its capabilities may, when applied within the context of war, do more harm than good. This is not to deny the very great importance of the things that technology can do in war. However, when everything is said and done, those which it cannot do are probably even more important. Here, we must seek victory, and here it will take place—although not necessarily in our favor—even when we do not. A good analogy is a pair of cogwheels, where achieving a perfect fit depends not merely on the shape of the teeth but also, and to an equal extent, on that of the spaces which separate them.

In sum, since technology and war operate on a logic which is not only different but actually opposed, the conceptual framework that is useful, even vital, for dealing with the one should not be allowed to interfere with the other. In an age when military budgets, military attitudes, and what passes for military thought often seem centered on technological considerations and even obsessed by them, this distinction is of vital importance. In the words of a famous Hebrew proverb: The deed accomplishes, what thought began.

Martin van Crevald
Technology and War

Current egress TCI policies and procedures for the F-15D/E aircraft work; however, because of the unique challenges and requirements an AEF presents, current policies and procedures need to be adjusted accordingly to better meet AEF taskings.

This analysis—sponsored by the Deputy Chief of Staff, Air Force Installation and Logistics, Directorate of Maintenance—is a follow-on to the joint RAND/Air Force Logistics Management Agency (AFLMA) study, *Leveraging Logistics to Enhance the Effectiveness of Air Expeditionary Forces (AEF)*. Over the course of this study, the Agency focused on deploying unit preparations and looked at three scheduled maintenance activities for the F-15D/Es: the number of phase inspections accomplished, number of engines changed, and number of egress time change items (TCI) replaced in preparation for a deployment. An area of concern was the significant spike in the number of egress TCIs being replaced on the aircraft scheduled for deployment. Preliminary analysis showed that, depending upon how the TCIs are replaced, as single items or as a combination of items, an F-15D/E would have between 24 and 170 egress TCI maintenance events performed on it over a 20-year period.

AFLMA Analysis

Master Sergeant
Maura Barton

Consolidating

egress time-change items

Since this is a significant amount of maintenance, the possibility for a common frequency among the TCIs was researched. Research revealed that 42 months was common to most items, with the exception of three items that have 36-month frequencies. Based on this, if egress TCIs were consolidated into a 42-month maintenance cycle, an F-15D/E would have six egress TCI maintenance events performed over 20 years. Factoring in the TCIs with the 36-month frequencies (7 egress TCI maintenance events over 20 years), an F-15D/E would have a total of 13 egress TCI maintenance events performed over 20 years. If the items with the 36-month frequencies could be increased to 42 months, then the number of egress TCI maintenance events would decrease to six over a 20-year period. This would be a significant reduction in the number of egress TCI maintenance events and possibly aircraft downtime.

Research also revealed a mandatory 36-month advanced concept ejection seat (ACES II) inspection, which involves complete disassembly/reassembly of the seat, and an opportune time to replace egress TCIs. This 36-month seat inspection was a major factor in considering a 36-month maintenance cycle versus the preliminary 42-month maintenance cycle. Therefore, by consolidating TCIs into a 36-month maintenance cycle, an F-15D/E would require seven egress TCI maintenance events to be performed over 20 years.

Two other alternatives were also considered:

- A 30-month maintenance cycle, which lends itself well as a multiple of the 15-month AEF cycles.
- A 12-month *look-out* policy, an extension of the current policy, that allows units to forecast, schedule, and replace parts up to 12 months in advance.

Tasking of the Egress Time Change Items Maintenance Schedule

The Air Force Directorate of Maintenance asked the Agency to determine the impact on parts cost, maintenance events/aircraft downtime, and maintenance man-hours if a 36-month maintenance cycle for all egress TCIs were implemented. The study focused on three main objectives:

- Determining the parts cost per F-15D/E aircraft to implement a 36-month maintenance cycle, a 30-month maintenance cycle, and a 12-month *look-out* policy for egress TCIs.
- Determining the proposal's impact and any cost savings for egress TCI maintenance events/aircraft downtime and maintenance man-hours.
- Evaluating the impact of revised egress TCI intervals on AEF deployment operations.

Assumptions

Only the F-15D and F-15E were used in the research because the ejection seats are identical with the exception of the SMDC (shielded mild detonation cord) line configurations. We only looked at egress TCIs and did not include any life-support or emergency equipment that may also be on the ejection seat. The study only focused on egress scheduled maintenance (two seat removals per year) actions and did not take into consideration any unscheduled maintenance actions that may occur. We used the AEF concept of operations from the Expeditionary Aerospace Force (EAF)/AEF Analytical Conference, November 1998, where every unit is assigned to a specific AEF, with a predictable deployment vulnerability schedule (15-month cycle). We did not include the SMDC line sets (Work Unit Code = 97AAH) in the analysis, as the set is replaced during programmed depot maintenance.

Constraints to Tasking

One objective was to determine the impact on aircraft downtime and any associated cost savings that would be gained by consolidating egress TCIs. However, we were unable to accurately measure this. In order to do this, we needed to map out the egress process step by step, beginning when the aircraft was *taken down* for scheduled maintenance, including each maintenance action (defuel, dearm, tow) and any *waiting times* in between, and ending when the aircraft was released back to the squadron. Research showed that in accordance with Air Force policies and procedures, TCIs should be considered for replacement in conjunction with other scheduled maintenance. Interviews with maintenance personnel revealed this is not being done at all bases—often deployments are dictating when TCIs get replaced and not necessarily other scheduled maintenance. With this in mind, an attempt was made to map out the process, but due to variability in the egress process among the bases and insufficient or unavailable information showing the *waiting times* between each step, this objective was not met.

The cost estimates in this study are based on assumptions made/listed throughout the analysis. Because of the amount of variability in the egress TCI maintenance process among the bases visited, the estimates in the study do not capture the variability of the entire process. However, the results do provide a rough idea of the magnitude of the quantifiable costs and benefits of the proposals presented in this study.

The Best Time to Perform Maintenance on Ejection Seats

The deployment preparation process is generally chaotic for everyone involved, and preparing ejection seats for deployments was identified as a stumbling block. Most other maintenance and inspections can be accomplished in theater; however, all egress TCI maintenance must be performed prior to deployment due to problems with customs and getting egress parts to forward locations. In addition to customs problems, the aerospace ground equipment and infrastructure required to perform egress TCI replacements at deployed locations are not always available. Also, scheduled maintenance should be minimized while deployed so resources can be directed toward accomplishing the primary mission of flying wartime sorties and ensuring aircraft are not unduly grounded. In the months and weeks before deployment, it is common for a unit to perform *predeployment prep* on 100 percent of its primary assigned aircraft (PAA), to include replacing any egress TCIs with a shelf/service life expiring while the unit is to be deployed.

Current TCI Policies and Procedures

Egress TCIs have a limited shelf and service life and must be replaced prior to the expiration date. If a part exceeds its expiration date, the aircraft is grounded. In terms of parts cost, the most efficient replacement policy is to use each part for its entire shelf and service life. Therefore, when the shelf and service life nears expiration, the aircraft should be taken off the flying schedule and the part replaced. Since aircraft downtime is an important consideration, it is more practical to perform egress TCI replacements when an aircraft is already down for some other scheduled maintenance action. According to Technical Order (TO) 00-20-1, *Aerospace Equipment Maintenance General Policies and Procedures*, maintenance personnel should:

> . . . consider TCIs due for replacement at the hourly postflight, home-station check, phased, periodic, minor or major isochronal, scheduled program depot maintenance, and so forth nearest to the replacement date.

With this in mind, as the schedulers plan to remove an aircraft from the flying schedule for scheduled maintenance, such as a phase inspection, they will also look for any other maintenance (egress TCIs, delayed discrepancies, and so forth) that can be accomplished while the aircraft is down.

Deployment Preparation Process

Using a planning requirements listing from the Core Automated Maintenance System (CAMS), which lists the maintenance requirements and forecasts the inspections and time changes that come due within a specified period of time (generally 6 months), maintenance schedulers can determine what maintenance needs to be accomplished prior to the deployment.

Even though schedulers look out 6 months in advance, there are limits as to when items can be replaced due to restrictions on the parts forecasting and ordering processes. Air Force Instruction (AFI) 21-101, *Maintenance Management of Aircraft* states, "Order all items requiring time change up to 60 days before the required month. Order munitions items 60 days before the beginning of the month required."

The maintenance scheduler then coordinates with egress personnel to determine if they can support replacing the TCIs. If the egress shop cannot support egress maintenance to coincide with other scheduled maintenance, the aircraft will be scheduled for maintenance at a later date, causing additional aircraft downtime. If the egress shop can support replacing the items, munitions operations (supply) is notified of the pending maintenance action, the date the action is to be completed, and the parts needed. Munitions operations (supply) then ensures the requested parts are available. Prior to the aircraft's being placed in scheduled maintenance, an Air Force Form 2005, Issue/Turn-in Request, is sent to munitions operations (supply) requesting issue of the parts. Once the parts are replaced, they are turned in to munitions operations (inspections). Inspection personnel assign each part a condition code, depending on how much service and shelf life remains. The assigned condition code indicates disposition of the part: disposed of, returned to the air logistics center (ALC), or put back on the shelf for possible reissue.

Most egress TCI maintenance requires the ejection seat to be removed prior to maintenance; however, it often takes more time to remove the seat than it takes to replace the part. Facilities (hangars) must be available prior to the seat removal for the crane and crew to get into place. Due to crowded cockpit conditions, there is a risk of causing damage to the aircraft and other systems whenever an ejection seat is removed. For these reasons, everyone involved in egress maintenance stresses that seats should be removed as infrequently as possible. The current policy of balancing replacement costs against the desire to combine egress TCI with other scheduled maintenance, while at the same time trying to limit the number of seat removals, results in every seat visiting the egress shop an average of twice per year.

The Steps Taken

We obtained F-15D and F-15E egress TCI schedules that listed each egress item, the service life (date of installation), the shelf life (date of manufacture), national stock numbers (NSN), and part numbers. Using a Federal Logistics (FEDLOG) compact disk, we obtained prices for each NSN and determined which one was the *Master NSN*. We then obtained, from subject matter experts, estimated crew size and task duration for each TCI item and the seat-removal process. We reviewed existing policies and procedures for egress TCIs in Air Force instructions and technical orders. After discussing current methods and policies for replacing TCIs with subject matter experts, we determined the impact on parts cost, the number of maintenance events/aircraft downtime, and maintenance man-hours that would result from a reduction in maintenance events and aircraft downtime. Comparisons were then made between the current egress TCI procedures and a 36-month maintenance cycle, a 30-month maintenance cycle, and a 12-month *look-out* policy.

Options

Charts that depicted the flow of three egress TCI maintenance schedules were developed. Figure 1 illustrates the egress TCI maintenance schedule under current policies and procedures. Figures 2 and 3 illustrate the egress TCI maintenance schedule under a 36-month maintenance cycle and a 30-month maintenance cycle. We also considered a 12-month *look-out* policy; however, since this policy is an extension of the current policies and procedures, the data were not charted.

Current Policy for Egress TCIs

Using the egress TCI maintenance schedule of a sample unit with 24 PAA, the following assumptions were made: every aircraft in the unit has scheduled egress TCI maintenance once every 6 months, and the workload is balanced such that the egress shop is only scheduled to work on seats from one tail number at a time. Figure 1 represents a feasible schedule of the current egress TCI maintenance requirements for the 24 PAA over a period of 36 months. A "+" sign indicates when each of the 24 PAA would be scheduled for egress TCI maintenance. A depiction of the new 15-month AEF cycle is overlaid at the top of the chart to show how egress TCI maintenance lines up with respect to the deployment vulnerability window for the unit. Under the EAF concept of operations from the EAF/AEF Analytical Conference, every unit will be assigned to an AEF, which will have a predictable schedule for deployment vulnerability. The 15-month cycle consists of approximately 9 months of *normal* operations, 3 months of deployment preparation, a 3-month deployment *on-call* window, and a few weeks of stand-down time. In Figure 1, a circle is drawn around all of the "+" signs that correspond to egress TCI maintenance scheduled to occur during the unit's *on-call* period. This egress TCI maintenance must be accomplished off schedule and prior to deployment to ensure no aircraft is grounded in theater due to inability to perform egress TCI maintenance.

The circled "+" signs in Figure 1 illustrate that 12 of the 24 PAA at the sample unit would require egress TCI maintenance off schedule to prepare the unit for deployment. For this example, it was assumed that the egress workload was well balanced and the egress shop was scheduled to work on seats from one tail number at a time. In a more realistic scenario, the egress workload would be more erratic, leading to more off-schedule egress preparation for deployment. The results of this example support what has been observed in the field and serve to illustrate the deployment preparation difficulties that are the focus of this study.

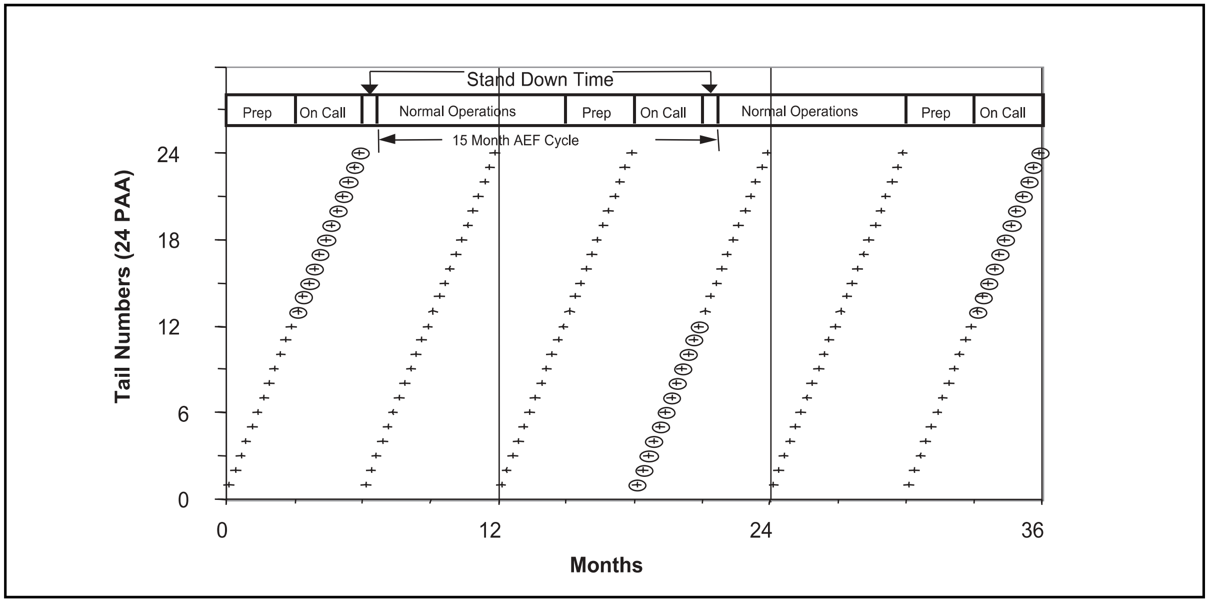


Figure 1. Current Egress TCI Policy

36-Month Maintenance Cycle

The first proposal involved consolidating all egress TCI maintenance into one recurring maintenance cycle. Since there is already a 36-month ACES II seat inspection (when the seat is completely stripped down and parts are easy to replace), it is practical to consider scheduling the egress TCI maintenance on a 36-month maintenance cycle. The 36-month maintenance cycle would look at the remaining service and shelf life of every egress TCI at the 36-month ACES II seat inspection and replace every part that would expire before the next seat inspection. With this policy, a seat is only removed (for scheduled maintenance) once every 3 years. This policy results in increased parts cost due to an increase in the frequency of part replacements, but it also results in a decrease in maintenance man-hours (and possibly aircraft downtime) due to a decrease in the frequency of seat removals and elimination of any downtime specifically for egress. The effect on AEF preparation is a significant reduction in the number of aircraft that will require off-schedule egress TCI maintenance. Figure 2 illustrates this effect.

Figure 2 uses the same 24-PAA sample unit (as in Figure 1) and makes the same assumption: the egress workload is balanced such that the egress shop is only scheduled to work on seats from one tail number at a time. A "-" (dash) indicates when each of the 24 PAA would be scheduled for egress TCI maintenance and the circled "-" indicates egress TCI maintenance that must be accomplished off schedule in order to accommodate the AEF *on-call* window.

Figure 2 shows that a 36-month maintenance cycle reduces the number of aircraft that require off-schedule egress TCI maintenance from 12 (current policy) to 2 of the 24 PAA.

30-Month Maintenance Cycle

The second egress TCI maintenance proposal is similar to the 36-month maintenance cycle except it is based on a 30-month maintenance cycle. This policy, however, requires the current 36-month ACES II seat inspections to be performed 6 months early. Like the 36-month maintenance cycle, the 30-month maintenance cycle results in an increase in parts cost but a decrease in maintenance man-hours and possibly aircraft downtime. The difference is that, in exchange for an increase in the frequency of seat inspections, the 30-month maintenance cycle is better suited for a 15-month AEF cycle. Any recurring egress maintenance originally scheduled in the *normal operations* or in the *prep* phase of the AEF cycle will always occur at the same point in future iterations of a 15-month AEF cycle. Assuming that a unit's AEF cycle will always be on track, it is possible to set up an egress maintenance schedule such that it should never be necessary to perform off-schedule egress TCI maintenance to prepare for an AEF deployment. Figure 3 illustrates this concept. A "-" (dash) indicates when each of the 24 PAA would be scheduled for egress TCI maintenance.

This proposed maintenance cycle is dependent upon a 15-month AEF cycle. Should the cycle change (12-month or 18-month AEF cycle), this 30-month process would clump together egress TCI maintenance events that could otherwise be more evenly distributed.

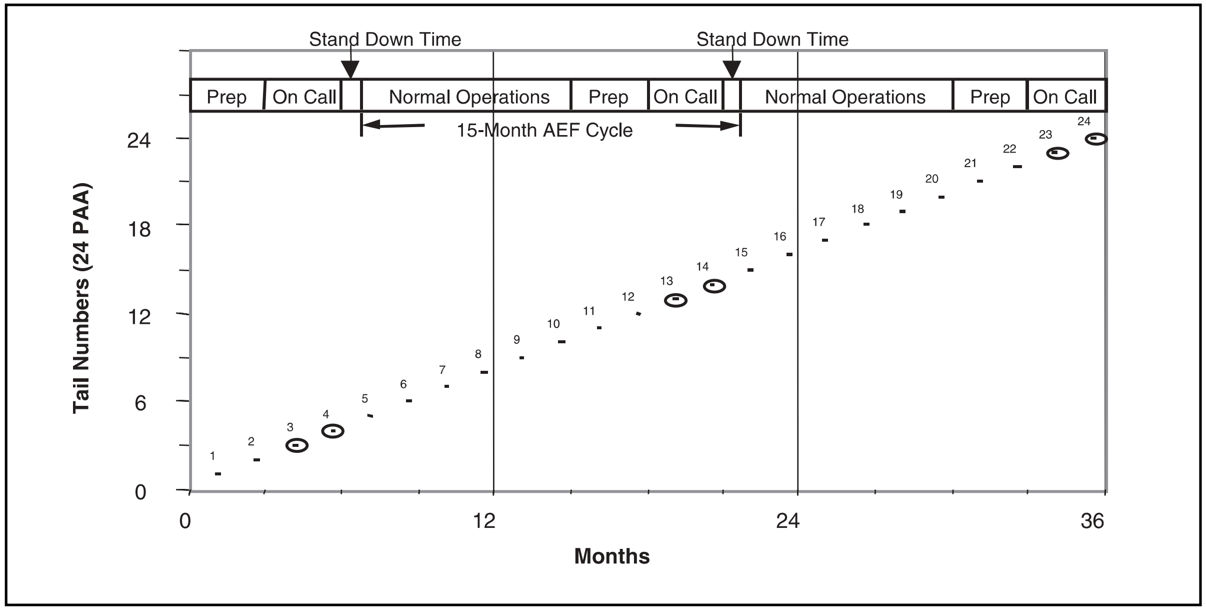


Figure 2. 36-Month Maintenance Cycle

12-Month *Look-Out* Policy

Both the 36-month and the 30-month maintenance cycles call for an increase in the frequency of egress TCI replacements. This increased replacement frequency leads to a direct increase in parts cost. For this reason, this study also considered a third policy alternative that addresses the deployment preparation issue with a smaller increase in parts cost. This policy proposal, the 12-month *look-out* policy, is an extension of the current egress TCI maintenance policy and offers more efficient deployment preparation but does not reduce the number of seat removals. Under the current egress TCI policy, maintenance schedulers look for egress items that will expire within 6 months of any scheduled maintenance action. If schedulers could order parts further in advance and replace parts sooner, the system would be more flexible, and egress preparations could be made further in advance of deployments. However, with schedulers looking further out, parts will be replaced ahead of the programmed change, and more service and shelf life will be lost. This loss of service and shelf life represents an increase in parts cost, but the increased cost is much less than with a 36-month or a 30-month maintenance cycle.

The Impact

There are some quantifiable costs and benefits that can be measured in this study: the effects of a policy proposal on seat removals, parts cost, and egress maintenance man-hours. The first of these quantifiable effects, seat removal reduction, is the easiest to demonstrate.

Removing the Ejection Seats

There are many benefits to removing ejection seats from aircraft less frequently, but only one is easy to quantify: the direct reduction in egress maintenance man-hours. The following assumptions were used to analyze the impact of fewer seat removals on egress maintenance man-hours:

- Each aircraft has two seats.
- Each seat is currently removed approximately twice a year for scheduled maintenance.
- A crew of three is required for a seat removal.
- Each seat removal takes an average of 2.75 hours.

Based on these assumptions, Table 1 reflects the average number of seat removals and estimated man-hours per aircraft, per year for the current egress TCI policy as compared to each of the three

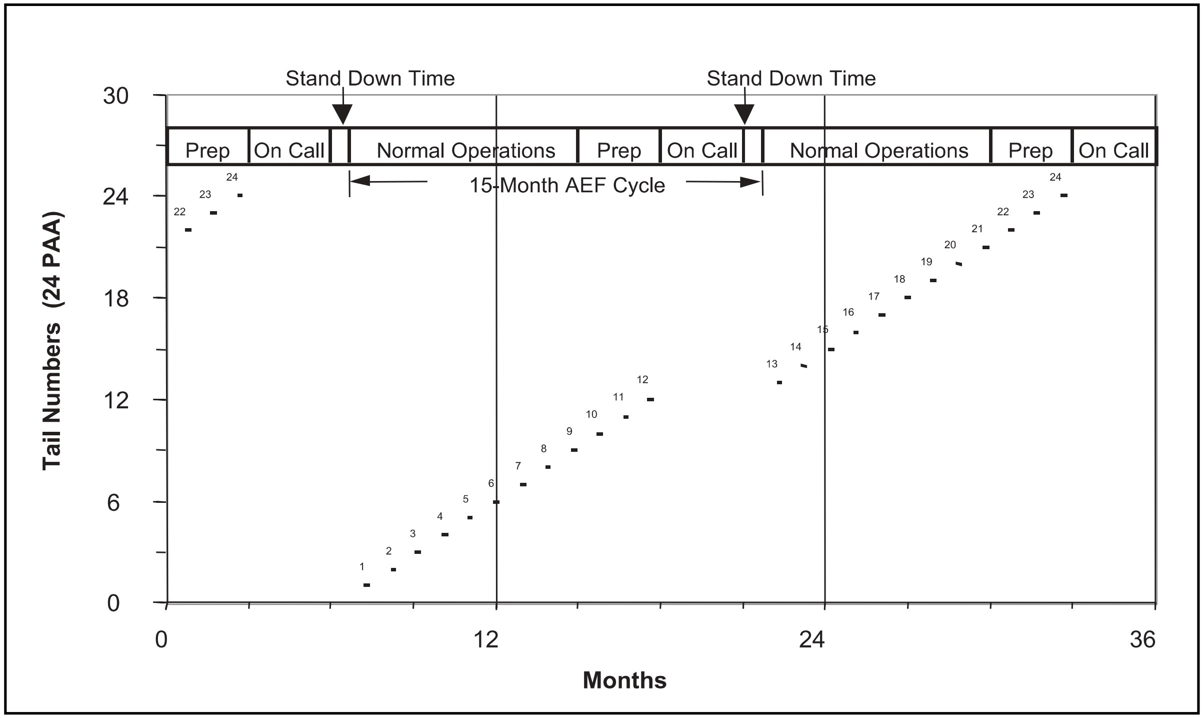


Figure 3. 30-Month Maintenance Cycle

	Current	12-Month	30-Month	36-Month
Average number of seat removals	4	4	0.80	0.67
Estimated annual man-hours for seat removal	33	33	6.60	5.50
Change in annual man-hours from current procedure	NA	0	-26.40	-27.50

Table 1. Average Number Yearly Seat Removals and Man-Hours

proposals. It illustrates that a reduction in the number of seat removals for scheduled egress TCI maintenance leads to a direct reduction in maintenance man-hours. The 36-month and 30-month maintenance cycle information has been converted to yearly averages so they can be compared with the current policy and the 12-month *look-out* proposal.

Average Annual Parts Cost and Replacement Man-Hours

Two other quantifiable costs that we measured are the annual parts cost and part replacement man-hours. All three proposals (the 36-month maintenance cycle, the 30-month maintenance cycle, and the 12-month *look-out* policy) require parts to be replaced more frequently than the current policy. To accurately estimate any increase or reduction in the parts costs and replacement man-hours, we considered:

- Unique Service Lives. Since each part has a unique service life, the analysis was conducted on a part-by-part basis. For a given egress TCI, there may be multiple national stock numbers representing the same part manufactured by different vendors. Even though these multiple numbers are interchangeable, they may have significantly different costs and service lives. To account for the differences in costs, service life, and vendor, the annual cost and man-hour estimates for a given TCI were computed as a weighted sum of the cost and man-hour estimates for each of the interchangeable numbers.
- Parts Distribution. To determine the distribution of parts, available by NSN through supply, we considered various methods for obtaining historical data. These methods included the purchase records from the air logistics center, the expenditure records from the Combat Ammunition System (CAS), and the disposal records for parts with expired service and shelf lives. However, each of these methods has the same problem: past availability does not accurately reflect future availability, largely due to the part requirements being contracted to different vendors. Therefore, there is the potential for historically estimated distributions to be seriously flawed. For this reason, this analysis makes the following assumptions instead of attempting to estimate historical distributions. If an egress TCI has a single NSN designated as the master NSN, the $P_{i,j}$ (probability that a demand for TCI i will be satisfied with a part manufactured by vendor j) for the master NSN is set to 100 percent, and the $P_{i,j}$ for each substitute NSN is set to 0 percent. If an egress TCI has multiple NSNs designated as the master NSNs, the $P_{i,j}$ are set to give each master NSN equal weight, and the $P_{i,j}$ for each substitute NSN is set to 0 percent. If an egress TCI has no NSN designated as the master NSN, the $P_{i,j}$ are set to give each interchangeable NSN equal weight.
- The Maximum Serve Life Expectancy (From Time of Manufacture to Time of Teplacement) for a Given TCI.There are two life expectancies associated with each NSN used: shelf life (in years) from date of

manufacture and service life (in years) from date of installation.

The item managers and equipment specialists at the air logistics center noted that parts have an average of 21 months,[1] or 1.75 years, inventory holding time (when parts are *on the shelf* at depot or in transit) before being issued to a unit. If the shelf life is greater than the service life, we assume that the inventory holding time does not affect the amount of usable service life for the part. However, if the shelf life and service life are the same, we need to account for the inventory holding time. We do this by reducing the service life by 21 months, the average inventory holding time. With this in mind, we made the following assumptions to account for inventory holding time when determining the maximum service life for a TCI. If the shelf life is greater than the service life, the maximum service life for the TCI is the service life. If the shelf life equals the service life, the maximum service life for the TCI is the shelf life minus the point estimate of 21 months (1.75 years) inventory holding time.

To account for service life that may be lost when a part is replaced early, we interviewed maintenance schedulers, egress personnel, and munitions supply personnel, and determined the remaining service life of a removed part varied between 0 and 0.5 years (0 to 6 months). Therefore, we used 0.25 years, or 3 months, as the point estimate.[2]

Table 2 provides a summary of the estimated annual parts cost and man-hours per aircraft.

Sensitivity Analysis

The results reported in Table 2 used point estimates to show the effects of the various policies in terms of increased cost and reduced man-hours. This section obtains more robust estimates of these effects by taking into account the variability in the system.

Due to the range of possible values, we converted the inventory holding time and remaining service life of a removed part to random variables. Using these random variables, 5,000 iterations of a Monte Carlo simulation were accomplished to investigate the effects of variance on the results of the analysis (Table 2). For this sensitivity analysis, the choice of random variables used in modeling inventory holding time was based on information from the air logistics center and data from several units. The air logistics center noted that inventory holding times can range between 0.5 and 3 years (6 to 36 months). The point estimate for average inventory holding time of 1.75 years (21 months) was replaced with a Beta distributed random variable, derived from actual sample data from Langley, Seymour Johnson, and Eglin AFBs.

Based on interviews with maintenance schedulers, egress personnel, and munitions supply personnel, it was determined that the remaining service life of a removed part varied between 0 and .5 years (0 to 6 months). In this sensitivity analysis, a uniform distributed random variable replaces the .25 year point estimate used previously. This distribution assumes that it is equally likely for the remaining service life of any removed part to be anywhere between 0 and .5 years. This is based on the actual policies in place: schedulers are using the TCI expiration dates to forecast 6 months in advance; therefore, any given part can be replaced 0 to 6 months before its actual expiration date. Table 3 illustrates the results of the sensitivity analysis in terms of the possible range in parts cost and maintenance man-hours per aircraft per year. The table reports the minimum, maximum, and average results of the 5,000 iterations of the simulation. The man-hour figures in Table 3 reflect an increase (+) or decrease (-) from man-hours under current procedures.

Benefits

As indicated, each of the three policy proposals has different costs when compared to the current policies and procedures. However, the following intangible benefits may outweigh the costs incurred:

	Current	12-Month	30-Month	36-Month*
Parts cost reflecting service life change (delta)	$6,731.90 NA	$6,997.45 (+$265.56)	$8,026.96 (-$1,295.06)	$8,173.39 (+$1,441.49)
Part replacement man-hours reflecting service life change (delta)	36.62 NA	38.41 (+1.79)	39.86 (+3.24)	51.17 (+14.55)
Seat removal man-hours reflecting maintenance proposal changes (delta)	33.00 NA	33.00 (0.00)	6.60 (-26.40)	5.50 (-27.50)
Total man-hours (delta)	69.62 NA	71.41 (+1.79)	46.46 (-23.16)	56.67 (-12.95)

*The reason for the 36-month cycle's being more expensive, even though parts are replaced less frequently in comparison to the 30-month cycle, is due to the total amount of service life lost. We used the maximum service life that could be lost in the analysis, which theoretically is 36 months under the 36-month maintenance cycle and 30 months under the 30-month maintenance cycle.

Table 2. Annual Parts Replacement Cost and Man-hours Per Aircraft

	Minimum	Average	Maximum
Parts cost range–12-month proposal	$134.62	$248.87	$375.95
Parts cost range–30-month proposal	$505.29	$1,238.40	$2,131.40
Parts cost range–36-month proposal	$618.08	$1,523.00	$2,606.10
Overall man-hour impact–12-month proposal	+0.70 hrs	+1.65 hrs	$3.23 hrs
Overall man-hour impact–30-month proposal	-24.07 hrs	-18.27 hrs	-8.20 hrs
Overall man-hour impact–36-month proposal	-25.11 hrs	-16.47 hrs	-9.43 hrs

Table 3. Range of Annual Part Replacement Cost and Man-hours

- More efficient deployment preparation for AEF operations (a reduction in the number of aircraft that will require off-schedule egress TCI maintenance).
- Every seat removal that is eliminated represents one less chance to cause accidental damage or additional wear and tear to the aircraft itself or other systems located in a cramped cockpit. The reduced damage risk to other systems is a very significant benefit. However, there are too many unknown variables to accurately quantify the reduction in probability of collateral damage and its affect on aircraft availability.
- A seat can only be removed after an aircraft has been taken away from the flight line and extensive preremoval preparations have been made. If the requirement to remove seats is reduced (consolidating egress TCI maintenance actions), the associated requirement to remove an aircraft from the flight line is also reduced, leading to improved aircraft availability for other maintenance or operational use.
- Maintenance-free windows for egress TCIs for the duration of an AEF deployment.
- The ACES II seat inspection due date would be used for tracking purposes, eliminating the tracking of numerous individual item due dates.
- More predictable maintenance cycles will enable units/air logistics centers to better forecast for parts requirements.

Implementation Issues

In order for the 36-month maintenance cycle, the 30-month maintenance cycle, or the 12-month *look-out* policy to be implemented, some areas need to be addressed. In particular, the following policies need to be updated: AFI 21-202 (and major command [MAJCOM] instructions), AFI 21-101 (and MAJCOM instructions), AFI 21-112 (and MAJCOM instructions), TO 00-20-9, TO 00-20-1, TO 11A and 11P series.

Many studies and audits have attempted to remedy the forecasting policies that have always plagued the TCI system at all levels. Per the ALC item manager, only 60 to 75 percent of the annual forecasting requirements from units is reported to the air logistics center. Accurate forecasting is imperative in order for either the 36-month or 30-month maintenance cycles to work. Therefore, current forecasting policies and procedures need to be changed.

Additional funding will be needed for additional parts, disposal costs, and transportation costs.

The possibility of being issued a part with insufficient shelf and service time to make it to the next 36-month or 30-month cycle is a concern. During our sensitivity analysis, we ran into instances where a part with a 60-month shelf and service life remained *on the shelf* for 36 months before being issued. At this point, the part only had a 24-month shelf and service life remaining, causing the part to fall short of the next 36-month or 30-month maintenance cycle.

There is the possibility of parts failing an acceptance test. Production contracts are geared for items/parts to be built or purchased in *lots*. A select percentage of the items and parts are tested to see if they *fire as advertised*. When parts fail this test, production often falls behind and could throw off a 36-month or 30-month maintenance cycle.

The Investigation Continues

During our research, we came across some areas that could be considered for further study. These areas include the reconciliation of FEDLOG with CAS, the possibility of direct vendor delivery to units, and the establishment of an automated tracking program for maintenance inspections.

The FEDLOG and CAS systems do not reflect the same information. CAS is inconsistent with linkages between the NSNs—doesn't link every NSN to other suitable substitutes. FEDLOG will show all NSNs that are suitable substitutes for each item.

Currently, parts go to Hill AFB and remain there, using up shelf life, until they are issued to a unit. Direct vendor shipment, coupled with increased accuracy in parts forecasting (a projected benefit of predictable maintenance cycles), may benefit the overall process by further reducing the inventory holding times at the depots. By reducing the inventory holding time, the amount of usable shelf life for the parts increases, which, in turn, will offset the increased parts costs associated with the 30-month and 36-month maintenance cycles. (Currently, direct vendor shipment is occasionally done. However, in addition to the added expenses incurred, it is a difficult process for the item manager and vendors to task.)

Three bases are using an automated program that tracks their inspections. The program is updated weekly and kept on the local area network, enabling work centers to quickly review upcoming inspections. By utilizing this program, the wing and squadron schedulers save an average of 40 man-hours per week that were previously spent tracking inspections manually using a planning requirements listing from CAMS.

Policy Adjustments and Benefits

Based upon research and analysis, we concluded that the current egress TCI policies and procedures for the F-15D/E aircraft work, as evidenced by the proven ability of units to deploy and sustain operations. However, due to the unique challenges and requirements an AEF presents, current policies and procedures need to be adjusted accordingly to better meet the AEF taskings. Making adjustments to the current policies and procedures does not come without cost. Although there is an increase in parts cost for both the proposed 36-month or 30-month maintenance cycles and the 12-month *look-out* policy, the intangible benefits gained may outweigh the increase in parts cost.

Looking Down the Road

A short-term recommendation is to implement a 12-month *look-out* policy for F-15D/E egress TCIs and incorporate previously recommended TO changes, which identified/proposed time interval changes to current policies.

Long-term recommendations are to consider establishing a transition team to implement either a 36-month or 30-month maintenance cycle for F-15D/E egress TCIs, explore the feasibility of adopting the same maintenance cycle for other aircraft with the ACES II seat, and incorporate a change/capability to track egress TCIs based on the ACES II seat inspection due date in addition to the date of installation and date of manufacture of each TCI.

Notes

1. With the possibility of inventory holding times ranging from 6 to 36 months and the remaining service life after TCI replacement ranging from 0 to 6 months, the parts cost reflected in Table 2 could be significantly affected. Therefore, we performed a sensitivity analysis to reflect how the variance in inventory holding times and remaining service life could affect the parts cost for each of the proposals.
2. *Ibid*.

To be blunt, delivering the required equipment, to the right hands, at the right place, and at the right time, remains the overriding challenge for any logistic organization.

—Air Commodore Peter Dye, RAF

The common habit of referring to technology in terms of its capabilities may, when applied within the context of war, do more harm than good.

—Martin van Crevald

Experience has taught me that manufacturers are now as necessary to our independence as to our comfort.

—Thomas Jefferson

The essence of flexibility is in the mind of the commander, the substance of flexibility is in logistics.

—Admiral Henry Eccles, USN

Logistics Systems

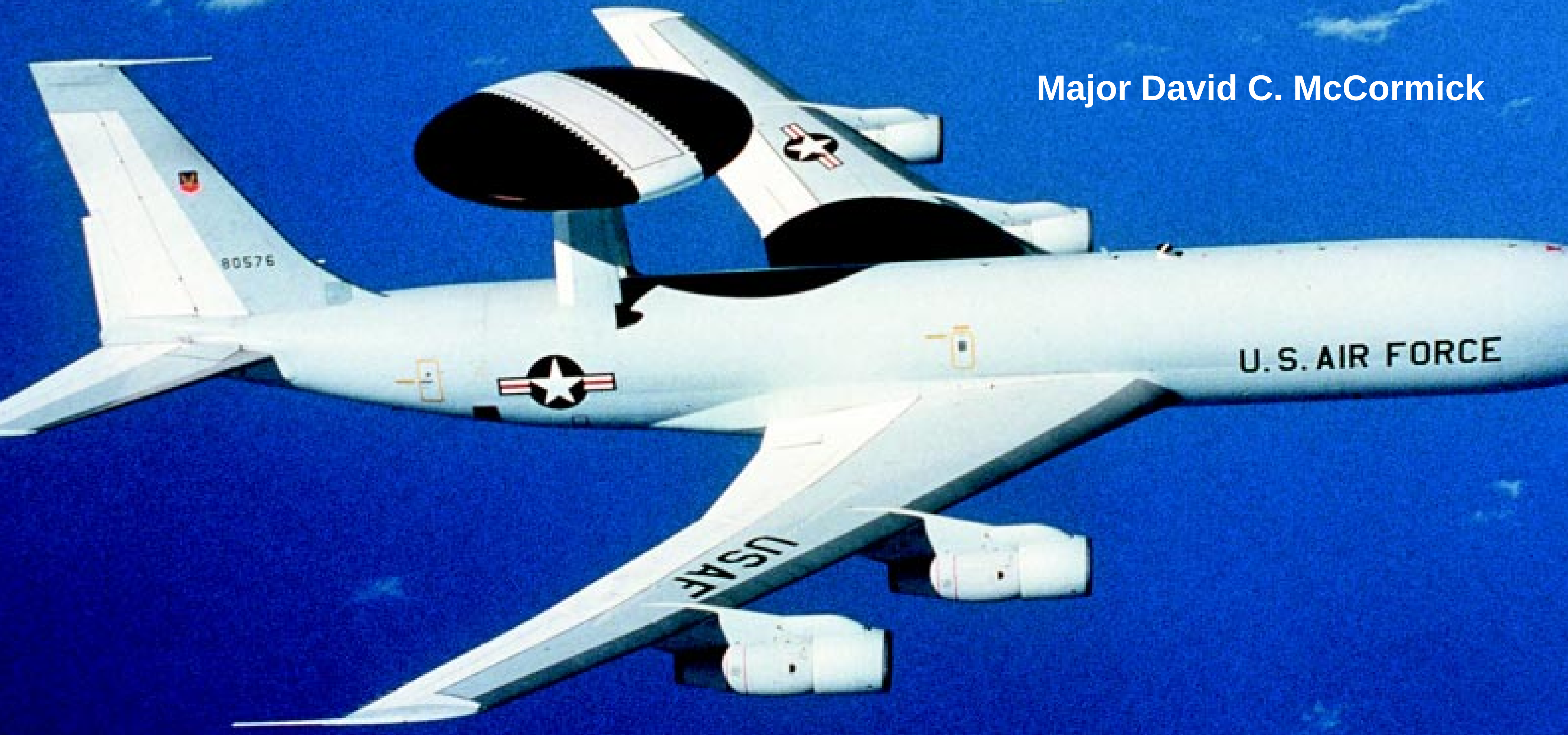
The supply of modern armed forces requires not just the production of material and the availability of adequate transport. A logistics organization must be structured . . . . In addition, the concentration of massive and technologically advanced armies and navies in new locales demands the construction of entire infrastructures: barracks, warehouses, port facilities, road networks, and airfields. This explains the fact that construction materials became a major item in modern military supply.

For each major 20th century war, the United States fashioned a logistics system tailored to the particular threat; no previous response could simply be dusted off and put back in place. World War, I, World War II, and the Korean War all presented unprecedented situations. The decision to increase the US commitment in Vietnam, 1964-65, demanded similar creation and improvisation.

John H. Lynn
Feeding Mars

Allied Force
E-3 Spares Kit Adequacy

Major David C. McCormick



Gentlemen, the officer who doesn't know his communication and supply, as well as his tactics, is totally useless!

—Lieutenant General George S. Patton

The Air Force E-3 Airborne Warning and Control System (AWACS) provides the indispensable "all-weather surveillance, command, control, and communications needed by commanders of US and NATO [North Atlantic Treaty Organization] air defense forces." It is a critical component of every air operation in which US forces participate.[1] Indeed, during Desert Storm, E-3s provided critical radar surveillance and aircraft control to friendly forces, with their airborne controllers participating in 38 of 40 recorded air kills.[2] Not surprisingly, other nations fully recognize the value of an AWACS, and NATO, Britain, and France have all acquired E-3s.[3] Most recently, E-3s played a decisive role during air operations in Kosovo.

The E-3 is both a complex and aging aircraft. In addition to *normal* airframe components, the E-3 is literally packed full of high-tech radar, navigation, communication, and computer systems, all mission essential systems in supporting the resident air battle management staff. While this high-tech suite of equipment does permit phenomenal surveillance and intercept events to occur in modern air warfare, it also presents significant maintenance and supply challenges to personnel charged with ensuring that mission-ready aircraft are available for each day's air tasking order.

This article focuses on the specific logistics challenges and spare parts adequacy experienced during the 78-day air campaign in Kosovo, Operation Allied Force. In order to put E-3 support during the operation in context, a review of overall-fleet E-3 spares support during FY99 is presented here.

Vital Role of AWACS in Air Operations

As already mentioned, the E-3 is core to any package of air assets being assembled by a joint forces air component commander. In fact, AWACS plays such a critical role in air operations that large-scale exercises face the threat of cancellation when AWACS is unavailable. Simply put, E-3s are an indispensable part of today's airpower.

Today's E-3 Fleet Is Heavily Tasked

E-3 aircraft and crews were operating at a hectic pace well before Desert Storm commenced, and the stress on certain systems is beginning to show. Currently, there are a number of forward-deployed operating locations. The typical aircraft averages many days away from home station each year, although these locations maintain very limited supply functions. As a result, logistics support is quite a challenge since forward-deployed units have minimal supply support beyond the deployed spares. As depicted in Figure 1, E-3s operate virtually around the world.

Since forward locations generally maintain only two to four E-3s on station at any given time, keeping aircraft mission capable in support of daily operations

In reviewing both the NATO and US-owned E-3 logistical support provided to deployed aircraft during Operation Allied Force, it is likely the high in-service rates could not have been sustained without the generous, timely loan of NATO spares.

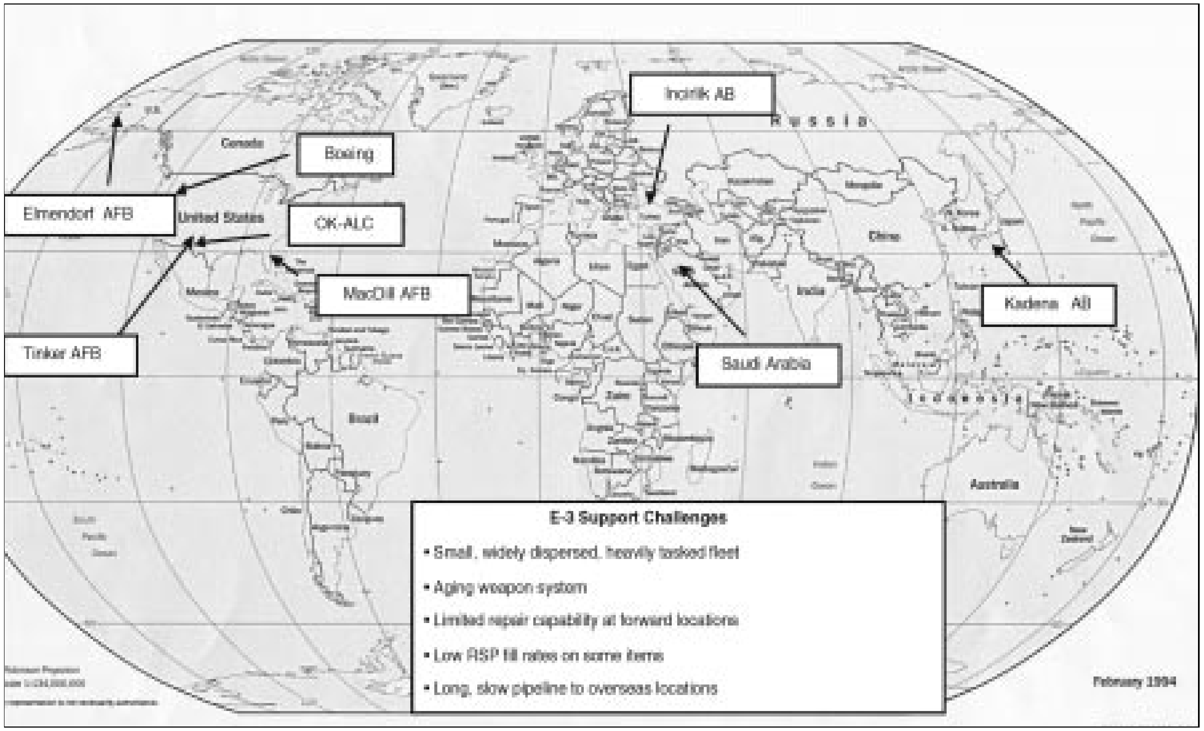


Figure 1. Many Different Operating Locations

is a substantial challenge. Supply operations are often frustrated by host-nation stipulations that US forces should not establish any base functions that look *permanent*, less the populace conclude deployed forces are something more than temporary visitors. Consequently, supply policy dictates that properly stocked mobility spares kits, vice well-stocked in-place spares kits, accompany deploying aircraft.

How the Air Force Determines Spares Requirements

Air Force logisticians expend great time and effort determining how many spare parts to include in support packages, known as readiness spares kits (RSP), that stand ready to accompany deploying air units. The operational maintenance objective of these RSPs is to support sustained combat operations for a minimum of 30 days without benefit of resupply.[4] It is not cost-effective, or supportable with limited airlift resources, to include all possible parts. Therefore, a computer model known as the Aircraft Sustainability Model (ASM) is used to determine which items are most worthy of inclusion. The model's function was recently described in the *Air Force Logistics Management Agency 3d Quarter in Review*:

> The ASM is the black box, analytical model embedded in the Requirements/Execution Availability Logistics Module (REALM). As such, it provides the program logic to compute the best mix of parts to include in mobility readiness spares packages.
>
> So we try to find a mix of parts that will satisfy, within our constraints, most of our needs. ASM computes a kit using marginal analysis, picking first the part that gives the most bang for the buck, then the next greatest bang for the buck, and so on until we run out of money or reach a predetermined aircraft availability goal.[5]
>
> As is generally the case in computer simulations, ASM model results are heavily influenced by maintenance ground rules, supply assumptions, and parameter estimates on key input variables such as planned flying hours, sortie rates, and mean time between failures (MTBF). Consequently, ASM often tailors kit contents to specific theaters of operation and employment schemes.[6]

Evolutionary Changes in Air Force Logistics

Since the early 1990s, the Air Force has embarked on a campaign to streamline the logistics process and reduce inventory levels. Furthermore, the shift to an expeditionary force has meant fewer deployments to forward locations with full maintenance support. Consequently, deployed forces are increasingly fighting wars in a *come-as-you are* fashion, highly dependent on organic spares kits and quick resupply. These conditions have long been the norm for E-3s.

The forerunner to agile logistics was *lean logistics*, a concept that envisioned reduced base and depot inventory levels but employed faster transportation to get parts more quickly to end users. By significantly reducing the pipeline time for expensive items transiting supply channels to and from bases, substantial savings were realized. Although actual component repair times have changed little, air transportation and immediate *first-in, first-out* attention at depots (elimination of idle time) have greatly shortened turnaround times.[7] From the growing pains of early lean logistics attempts, agile logistics was born.

Agile logistics explicitly focuses on increasing combat support to end-users and employs better demand-forecasting tools to anticipate repairs and parts requests, along with the previously mentioned rapid transportation. Former Air Force chief logistician Lieutenant General William P. Hallin observed that the repair cycle for a representative nonconsumable item had decreased from 31 days in FY94 to less than 22 days in FY97, a reduction of 30 percent.[8]

Supply Versus Maintenance Role in Resolving MICAPs–Keeping Score!

The Air Force has a well-established system of logistics metrics for determining how effectively supply and maintenance activities support a wing's aircraft fleet. Simply put, these metrics are used for tracking aircraft mission-ready status, monthly sortie rates, and nonavailability due to spare parts or maintenance shortfalls. When aircraft availability falls short of command expectations, the metrics provide a useful focal point for further examination.

The single most watched metric is probably the mission capable (MC) rate. Computations begin with a determination of how many hours in a given month each aircraft was in the wing's *possession* or control. Then a calculation is made to determine how many hours each of these aircraft was either fully or partially mission capable (FMC or PMC). Finally, the ratio of (FMC+PMC) to possession hours yields the MC rate. For the E-3 fleet, an Air Combat Command (ACC) standard of 85 percent MC has existed since FY96. Unfortunately, this expectation has rarely been met in recent years, although an exceptionally high MC rate was achieved for the E-3 during Operation Allied Force.[9] Figure 2 compares MC rates for Allied Force E-3s against the E-3 fleet.

When aircraft are nonmission capable, either supply or maintenance activities are charged with the hours an aircraft is out of service, depending upon the circumstances. As aircraft parts break and must be replaced, wing maintenance personnel perform diagnostic and repair activities to locate the offending components. Needed replacement parts are requisitioned from base supply, spares kits, or back ordered. During periods when wing aircraft are unavailable due to maintenance activity, those hours are charged against maintenance; however, once a replacement part has been requested, the supply function's clock begins running. In the E-3, three main areas (engines, surveillance radar, and fuel system) occupy the majority of fleet maintenance and supply demand activities, consequently, possessing sufficient spares for those items that frequently need replacement is critical to achieving high MC rates.[10]

Logistics Support Concept for Deployed E-3 Packages

The Air Force logistics system is large and complex, but agile logistics has already shown us how we can improve support to our warfighters.

—Lieutenant General William P. Hallin

Because of its indispensable role in deployed air operations, E-3 maintenance and spares support is a high priority for both Air Force Materiel Command (AFMC) and Air Combat Command. However, the E-3 is an aging system, and three different ongoing modification programs (20/25, 30/35, and Radar Systems Improvement Program) significantly complicate logistics support. Furthermore, fiscal constraints and limited airlift assets dictate that spares kits be limited to the minimum size necessary to meet operational readiness objectives.

Planning Factors Versus Reality

The first step in spares planning for any system is estimating requirements (parts demand) based on anticipated flying hours, sortie rates, and historical module failure rates. For the E-3 fleet, the primary planning factors are planned (programmed) flying hours and component MTBF rates, as documented in the 15-month supply demand data reported by the E-3 fleet bases during the annual kit review.

Two types of spares kits containing reparable parts currently exist for the E-3 system: mobility readiness spares packages and in-place readiness spares packages (IRSP). The single IRSP exists at Kadena AB, as political sensitivities in Turkey and Saudi Arabia preclude establishing any US Air Force E-3 maintenance capability or level of provisioning that looks *permanent*. The remaining

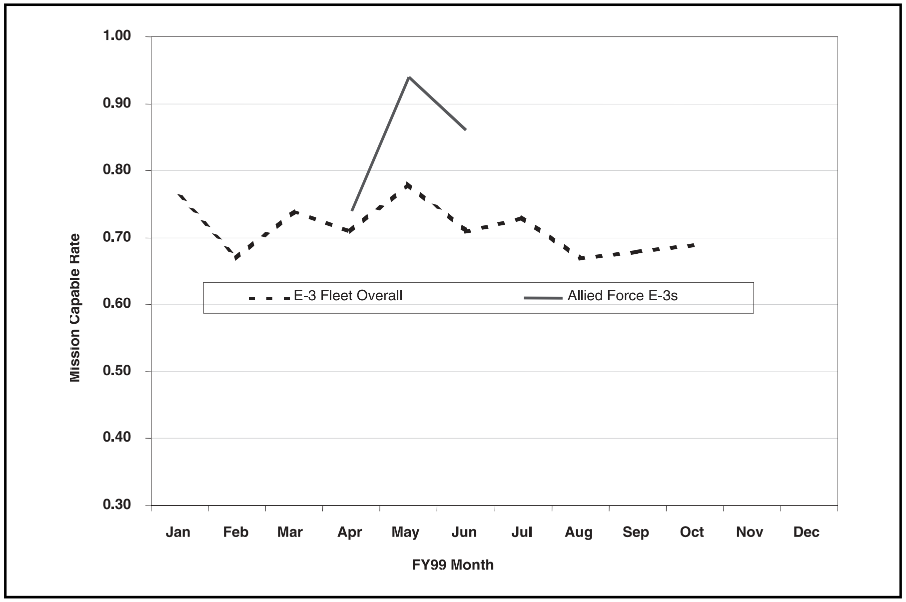


Figure 2. Comparison of E-3 MC Rates

nine spares kits are mission-ready spares packages (MRSP), configured and located as shown in Table 1. Differences in Tinker AFB-authorized kit item quantities are due to the necessity of supporting three different ongoing E-3 modifications.

Table 2 reflects *planned* versus *actual* E-3 flying-hour experience, aggregated for the fleet and broken out by deployed location during FY99. In theory, a close match between actual flying hours and programmed flying hours at a given location allows great accuracy in estimating actual supply demands and facilitates an informed decision on which spares kits to deploy. However, since Operation Allied Force was ill-planned (from the flying-hour budgeting perspective), that campaign's E-3 flying hours largely developed from home station accounts.

Role of the Tinker AFB Sentry Control Point

Because E-3s are the textbook case of a classic *high-demand, low-density* weapon system, which is continuously deployed in small numbers to numerous hot spots around the globe, 552[d] Air Control Wing and Oklahoma City Air Logistics Center (OC-ALC) personnel jointly operate a status-monitoring activity at Tinker AFB, known as the sentry control point (SCP). Established in 1979, the primary function of SCP is to provide a single point of *providing and coordinating positive logistical support* for the widely dispersed E-3 fleet.[11] Specific SCP activities include locating and shipping high-priority parts to solve mission capability (MICAP) situations at forward-deployed locations, a function that is exercised many times daily. During FY99, the SCP was actively involved in resolving 2,015 E-3 MICAP supply situations.[12] Table 3 compares SCP-controlled supply fulfillment times to the different deployed locations, clearly showing how increased use of commercial expeditors during the last several years reduced transportation pipeline periods.

By consistently providing focused priority attention, along with innovative delivery means, the SCP significantly improves fleet-wide E-3 readiness. (They often have rotating personnel hand-carry parts). During Operation Allied Force, the SCP coordinated the transfer of nearly 200 parts from NATO's E-3 supply system to US E-3 maintainers working MICAP issues at Geilenkirchen AB, thus enabling a high MC rate and near-zero *supply-out* condition.[13]

Spares Forecasting Methodology

The ultimate responsibility for determining what items to stock in the E-3 RSPs rests jointly with the using command and OC-ALC kit manager during an annual review held at Tinker AFB. Attendees include major command representatives from ACC and Pacific Air Forces, AFMC E-3 program office personnel, ALC equipment specialists, and personnel from the 552[d] Air Control Wing. As might be expected, there is ample higher headquarters' guidance for conducting such reviews (Air Force Manual 67-1, Chapter 14, *Readiness Spares Packages (RSP) and High-Priority Mission Support Kits [HPMSK])*.[14] How well this once-a-year process works for low-density aircraft like the E-3 is not yet clear.

During the kit review, two different RSPs are designed: a contingency package for the force as it currently exists and a buy package that forecasts desired kit composition 2 years into the future. The buy package—perhaps significantly different due to anticipated changes in fleet size, expected failure rates—only exists on paper and is computed in order to provide inputs to out-of-year budget cycles.[15]

LOCATION	PAA	TYPE KIT	Authorized Number of Items
Tinker AFB	3	MRSP	731
Tinker AFB	3	MRSP	893
Tinker AFB	3	MRSP	810
Tinker AFB	2	MRSP	810
Turkey	3	MRSP	731
MacDill	2	MRSP	731
Saudi Arabia	3	MRSP	893
Saudi Arabia	2	MRSP	731
Elmendorf	2	MRSP	948
Kadena	2	IRSP	703
Totals	25	Both Types	7,981
Source: OC-ALC E-3 RSP Inventories			

Table 1. FY99 E-3 Reparable Spare Kit Types and Locations

	Programmed	Actual	Delta
Home Station	11,547	9,608	-1,939
Saudi (SW)	3,212	2,982	-230
Turkey (NW)	2,066	2,038	-28
Allied Force	NA	1,527	+1,527
ACC Total	18,354	16,156	-2,198
Kadena	1,200	1,146	-54
Elmendorf	2,519	1,927	-592
PACAF Total	3,643	2,908	-735
Entire Fleet	4,927	4,529	-398
Source: OC-ALC Indicators Report			

Table 2. FY99 Planned Versus Actual E-3 Flying Hours by Location

	Kadena	Elmendorf	MacDill	Saudi	Turkey
1994	7.7	2.40	-	5.8	5.4
1995	6.7	1.60	-	6.1	3.1
1996	4.8	.92	-	5.4	4.7
1997	4.7	.98	-	3.5	4.9
1999	4.2	1.00	2.0	3.1	4.0
Sources: OC-ALC briefing, SCP records					

Table 3. Comparison of E-3 MICAP Supply Fulfillment Times (Days)

Did Agile Logistics Change E-3 Kit Composition?

In discussions with both the ALC kit manager and the SCP office in charge, it appears that little, if any, change to E-3 RSP kit composition has occurred during the recent move to *agile logistics* as seen during the 1990s. This exception to the well-publicized (and sometimes criticized) Air Force-wide trend, in reducing spare's inventory levels and shifting from a three-level to two-level maintenance concept, largely missed the E-3 weapon system. The primary reasons include the unique E-3 concept of operations (CONOPS) of deploying small two- to three-ship packages, having only a single main operating base at Oklahoma City, and most important, a complex, expensive suite of equipment. In actuality, the E-3 supportability experience has been one of *lean logistics* for many years.

Today's E-3 Readiness Spares Kit

As mentioned earlier, the E-3 is a complicated, aging weapon system that has currently fielded aircraft configured in one of three different modifications: the block 20/25, 30/35, and RSIP variations. Because of these differences, RSP kits, while tailored, must still be robust enough to handle any configurations of aircraft that deploy. Moreover, aggregate spares costs increase by the necessity of maintaining parts for the various modifications.

Keeping RSP kits stocked at levels agreed upon during the annual kit review conferences presents a substantial challenge for reasons that will be discussed in greater detail later. Briefly, the challenges include unexpected decreases in MTBFs on certain parts, competing depot repair priorities, occasional lapses in vendor contracts, shortages in certain reparable items due to parts condemnations, and difficulties transferring failed carcasses back to depot in a timely fashion. In a system as complex as the E-3, many of the underlying causes remain invisible until such time as critical shortages of certain items develop.[16]

Table 4 shows aggregated, fleet-wide average kit fill rates over the last decade. As the data imply, kits accompanying deploying aircraft frequently have less than a full complement of desired parts. In recognition of this, a priority kit-fill scheme was developed that gives kit restock priority to operationally significant locations like Turkey and Saudi.

Maintenance Challenges During Allied Force

This data was key to our logisticians being able to aggressively manage the supply chain and speed urgently needed spares to the fighting units.

—Lieutenant General George Babbitt, AFMC Commander

Operation Allied Force represents something of an anomaly to logisticians responsible for E-3 support in that host-base support far exceeded anticipated levels, and standard RSP kits did not immediately arrive with deploying aircraft. Fortunately, since most US E-3 aircraft were forward deployed to Geilenkirchen where NATO operates its own fleet of E-3As, base maintenance stores and organic support facilitated a high *mission-ready* status. This friendly assistance occurred throughout the campaign, thereby minimizing adverse impacts from late E-3 RSP arrivals, delayed carcass returns, and communications challenges.

As shown in Figure 3, the Allied Force tasking did not result in an increased number of E-3 sorties fleet wide. Rather fleet-wide sorties continued to average 175 sorties per month, but training sorties at Tinker AFB were reduced as crews and spares headed to war. US E-3 sorties flown in Allied Force range from approximately 25 sorties in the first month to better than 50 sorties in the final month.

E-3 Deployed Supply and Maintenance Support

When E-3s deploy, supply/maintenance personnel and MRSPs either accompany, or closely follow, the aircraft within a few days. In cases where standard operating locations exist (Turkey, Saudi), in-place readiness spares, or mobility readiness spares, preposition and standing (but limited) maintenance functions exist. While this CONOPS worked quite well, ACC ordered E-3s to Geilenkirchen in support of Operation Allied Force. According to those familiar with the operation, insufficient airlift was available to move the standard MRSPs until 2 weeks after the initial deployment, thereby requiring US E-3 supply personnel to borrow a substantial number of reparable spare parts from the NATO E-3 system at Geilenkirchen.[17]

Opportune Logistical Support from NATO E-3 Stores

Fortunately, NATO has not yet adopted the Air Force's current lean logistics approach and instead maintains high levels of E-3 spares at Geilenkirchen. As mentioned earlier, when the initial package of three E-3s moved from their forward-deployed location in Turkey to Geilenkirchen, their RSP did not immediately accompany them.

E-3 MICAP Rates

E-3 MICAP *supply* rates during Allied Force were very low, primarily due to the previously mentioned superb logistics support from NATO's Geilenkirchen AB. According to the SCP, NATO E-

FY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Fill Rate	78%	81%	83%	76%	75%	80%	80%	79%	72%	76%
Source: OC-ALC Briefing, Slide 15										

Table 4. Average E-3 RSP Kit Fill Rates (of Authorized Level)

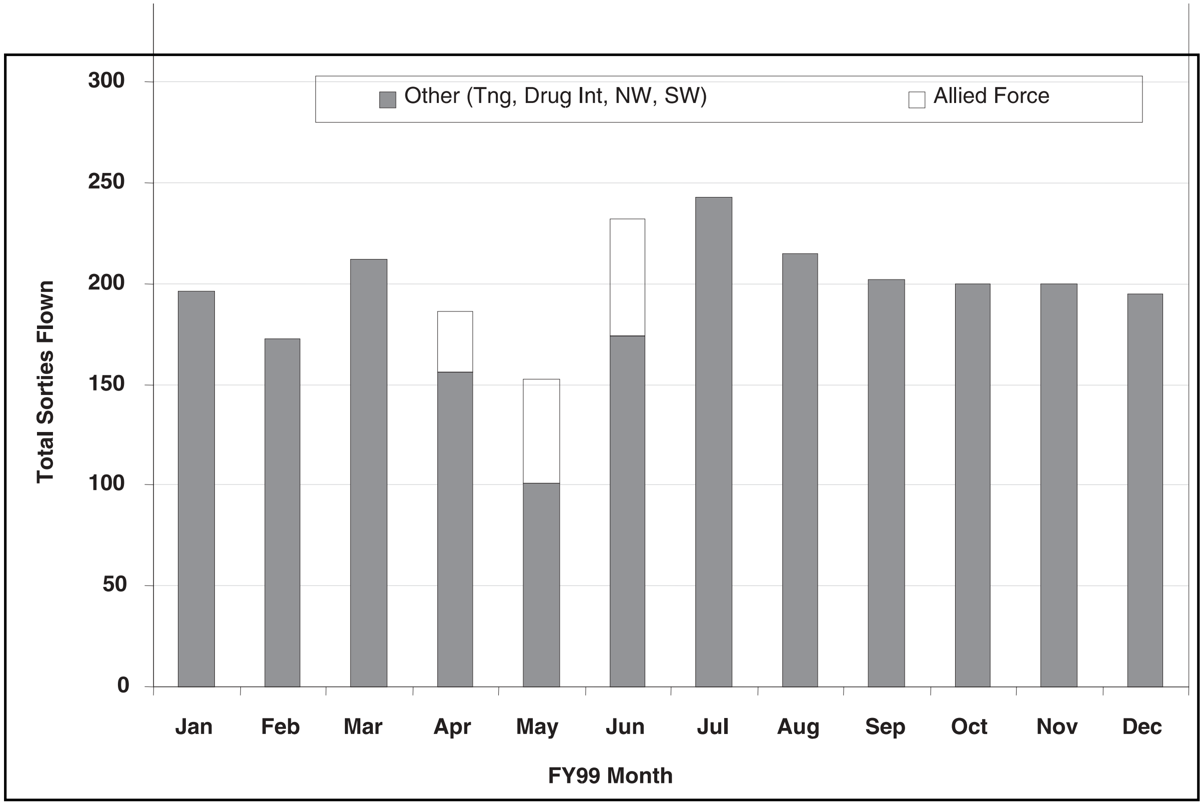


Figure 3. 552 ACW FY99 Monthly E-3 Sorties

FY	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Fill Rate	78%	81%	76%	75%	80%	80%	80%	74%	72%	76%
Source: OC-ALC Briefing, Slide 15										

Table 5. Average RSP Fill Rates by Fiscal Year

3s share greater than 90 percent commonality, but more important, NATO has not yet adopted a lean logistics approach similar to the United States. Consequently, there are large base-level spare inventories immediately available to maintainers when aircraft systems break, not thinly filled RSP kits.

Logistics Hangover from Depot Closures

E-3 spares support comes from several different depots and Defense Logistics Agency locations, thereby making system-wide support monitoring more difficult for the weapon system owners. Further complicating visibility into depot support issues is a *hangover* effect following depot closures at San Antonio and Sacramento ALCs. Unfortunately, the lost repair shop time occurring when one depot closed and another did not spin up until months later was aggravated when several key contacts with outside vendors lapsed. It was only after the new depot shop was up and running and low on parts that the out-of-date contracts were discovered.[18] The data in Table 5 clearly reflect the resulting impact on RSP fill rates, although other factors contribute as well. For example, higher break rates (shorter MTBF) could contribute to increased parts usage. Also, carcass condemnations effectively reduce inventory levels, making repair times more critical.

E-3 Supply Policy Analysis

> *The goal of the Air Force logistics system is to attain peacetime and wartime aircraft availability goals with the minimum amount of inventory and expense.*
>
> **—Dr Douglas J. Blazer**

In an ideal world, E-3 RSP composition would be closely monitored by the ASM sustainment model and require little or no adjustment. Spares demand data from the field would reflect consistent MTBF rates and not currently experience wide fluctuations in the E-3 fleet. Unfortunately, a variety of factors confounds supply demand, thereby requiring substantial interpretation of annual kit review results.

Recommendations for Kit Composition

Beyond those items needed due to E-3 system modifications, there have been surprisingly few dramatic changes to E-3 RSPs during recent years. A review of FY99 supply demand data, REALM-ASM results, and experiences during Allied Force suggest that the bigger challenge is not in *designing* kits but rather *keeping them stocked* to authorized levels. This is especially true as supply and repair functions spin up at new depot locations following the Base Reorganization and Closures at Sacramento and San Antonio ALCs. Oftentimes, individual item shortages can be traced directly back to *root causes* in the depot repair process, that had they been properly anticipated, would have been afforded higher AFMC depot repair priority before stock-out conditions occurred. The objective of perfect visibility into depot repair processes and carcass locations should continue as a primary item manager goal in hopes of preventing future MICAP situations.

Sensitivity to En Route Shipping Times

Table 6 provides various detailed readiness indicators for the E-3 fleet, both at home station (Tinker AFB) and several deployed locations. Several interesting observations can be made from reviewing the table. First, it is obvious that supply priorities in kit fills favor the deployed locations, vice home station. According to the SCP and OC-ALC, that is by design since home station missions are typically lower priority training sorties.[19] Compensating for lower RSP kit levels at Tinker AFB is the opportunity to cannibalize, from aircraft in depot maintenance, an event that SCP officials report took place 142 times in FY98 and 71 times in FY99.[20] While depot aircraft represent something akin to a *bonus* RSP, the cannibalization process constitutes a duplication of effort (working two aircraft for one part).

En route shipping times to the various deployed locations significantly impact MICAP duration and related mission-capable rates. In instances where the deployed location hosts only two or three aircraft, the difference of 1 or 2 days in shipping time, multiplied by 20 to 30 events per month, could make the difference between achieving the desired total not mission capable due to supply (TNMCS) rate or busting it. Consider a simple example of one aircraft in Saudi that requires four MICAP shipments per month. As shown in Figure 4, substantial reductions in delivery times resulting from SCP and depot rapid-fulfillment initiatives favorably impact TNMCS rates.

Increases in Kit Funding

A recent decision to increase E-3 RSP funding levels should raise kit fill rates substantially, although exact fill-rate numbers are currently unavailable. In a message to all MAJCOMs, the AFMC commander noted that changing operational requirements justifies increased spares expenditures and larger kit sizes.[21] For the E-3B system, the increase is approximately $13M more in spares funding. Estimates from the OC-ALC kit manager are that fill rates may reach between 85 and 90 percent once all the newly authorized spares are fielded.

	Aircraft Possessed	MC Rate	TNMCM Rate	TNMCS Rate	CANN Rate
Home Station	15.5	.69	.25	.12	.35
Saudi (SW)	3.5	.75	.17	.12	.10
Turkey (NW)	2.7	.76	.13	.15	.11
Allied Force	4.0	.87	.13	.01	.00
ACC Total	22.6	.72	.22	.12	.25
Kadena	2.0	.66	.22	.19	.15
Elmendorf	2.0	.80	.13	.12	.03
PACAF Total	4.0	.73	.18	.16	.08
Entire Fleet Totals	26.6	.69	.23	.14	.22
Determined by totaling hours possessed on all aircraft during the month and dividing by number of hours in the month.					
Source: OC-ALC/LAKMA Indicator Report					

Table 6. FY99 12-Month Aggregated E-3 Readiness Indicators

The Spares Support Challenge

The battle is fought and decided by the quartermasters before the shooting begins.

—Field Marshal Erwin Rommel

Because of the E-3's complexity as a weapon system and the all-too-well-known problems of supporting aging aircraft, it is likely spares support will continue to be a challenge in the coming decade. On the positive side, without question, a number of current spares-enhancement efforts (increased Boeing support, surplus parts buys, KC-135 parts cross matches) are paying great dividends by decreasing TNMCS rates. However, the sheer number of E-3 parts in the system makes effective tracking and analysis of every potential problem part difficult at best. Consequently, a *chasing-your-tail* drill is likely to continue as ever-new parts make the *top ten* worst offender list, perhaps facilitated by ongoing modifications that drive changes in MTBF rates. Shifting from a reactive spares-response mode is clearly a huge challenge but a necessary one if overall MC rates are to increase.

More than any other supply-related factor examined during the E-3 spares review, it appears that the SCP's close monitoring of worldwide E-3 MICAP situations (both real and threatened by temporarily reduced RSP kit levels), coupled with a highly-responsive OC-ALC E-3 element, offers the greatest potential of keeping TNMCS rates low. By closely tracking recent supply-out conditions at deployed locations, kit composition can be boosted immediately, and preemptive backfills initiated. As pointed out by SCP personnel, a lateral part transfer from one deployed location to another, with a backfill to the donor, is almost always faster than a stateside shipment to the MICAP holder. Moreover, the use of commercial shipping companies vice organic airlift through AMC saves precious days in getting needed parts to deployed locations around the globe.

Recognizing the limited small-fleet applicability of an aircraft sustainability model like PC-REALM remains a critical element in overall E-3 spares health, as it relates to kit composition. A uninformed headquarters view may suggest that

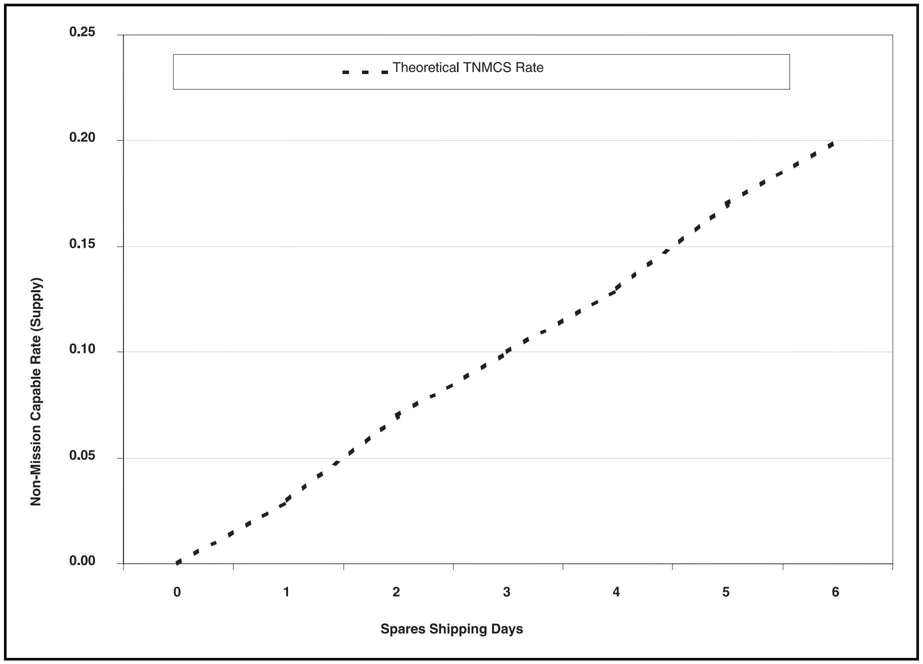


Figure 4. Impact of Shipping Times on Saudi NMCS Rates

model recommendations for kit levels might be considered gospel, but there is simply no substitute for kit manager good judgment and sanity checks during the annual kit review process. For example, the previous year's supply demand data on a particular reparable item might contain unusually large values, perhaps reflecting a temporary condition not likely to be repeated during the coming year. Such might be the case during ongoing aircraft modifications when newly delivered parts exhibit higher-than-expected failure rates early on, but recent engineering changes have now extended the MTBF and thus provide a better predictor if only the last few months are considered.

In reviewing both the NATO and US-owned E-3 logistical support provided to deployed aircraft during Operation Allied Force, it is likely the high in-service rates could not have been sustained without the generous, timely loan of NATO spares. Consequently, it would be imprudent to consider the operation an unqualified success from the logistical support standpoint, as it is unclear that RSPs and subsequent spares shipments would have been adequate. As noted in the Secretary of Defense and Chairman of the Joint Chiefs of Staff statement outlining the Department of Defense's after-action assessment of operations in Kosovo during Allied Force, limited in-theater airfields "slowed aircraft turnaround times, limited throughput, and slowed the onward movement of forces and humanitarian supplies."[22] This suggests that ultimately, the best spares solution of all is increased E-3 system reliability, as it would reduce the need for the current large number of spares and associated airlift support requirements.

Notes

1. "E-3 Sentry (AWACS)," USAF Fact Sheet 96-13, Department of the Air Force, Mar 96.
3. *Ibid.*
4. Capt Kevin J. Gaudette, "A Black Box That Works for You," *AFLMA: Third Quarter in Review*, Winter 1999, 19-20.
5. *Ibid.*
6. *Ibid.*
7. "Speed replaces size in Lean Logistic approach to inventories." *AF News*, 11 Apr 96, [Online] Available: http:///www.af.mil/news/Apr1996/n19960411_960336.html.
8. "Agile logistics: Where we've been, where we're going." *AF News*, 28 Apr 98, [Online] Available: http;///www.af.mil/news/Apr1998/n19980428_980559.html.
9. Author's interview with SMSgt Ann Polesky at OC-ALC, 8-9 Feb 00 and review of 552 ACW Maintenance Digest 9302.
10. OC-ALC/LAK, "E-3 Logistics Support Briefing," Overview briefing on E-3 spares support, Tinker AFB, Oklahoma, Feb 99.
11. Maj Chris Roach, "Background Paper on the AWACS Sentry Control Point," OC-ALC/LAKMA, 6 Dec 99.
12 Author's interview with Maj Roach, SCP, 8-9 Feb 00.
13. *Ibid.*
14. AFM 67-1, *War Reserve Materials,* Vol 1, Part One, 18 Nov 99.
15. AFM 67-1, 10.
16. SMSgt Polesky interview.
17. Maj Roach interview.
18. SMSgt Polesky interview.
19. Maj Roach interview.
20. *Ibid.*
21, AFMC/CC Message P311813Z JAN 00 to MAJCOM/CCs, 31 Jan 00.
22. US Senate, Joint Statement on the Kosovo After Action Review: Hearings Before the Senate Armed Forces Committee, 104th Cong, 2d sess, 1999.

The plan of embarking mules and men in the same ships was, in the first instance. objected to on the grounds that some ships were better able to carry mules than others and that the comfort of the troops would be greater if all animals were placed in separate vessels; but this objection was overruled by the Commander-in-Chief, who stated that he was convinced by history that the governing principle in preparing such expeditions was so to embark the force that every portion of it should be able to disembark, completely equipped from the ship or ships conveying it. This, he stated, was absolutely necessary if the landing was likely to be opposed, and was the best means of preventing confusion and delay even if there was no opposition.

—British Egyptian Expedition

Logistics Information Technology

Enabling communities supporting the Air Force logistics community must measure their performance in light of their contribution to their logistics customer's desired outcome. In short, they must map the *value stream* and increase its effectiveness and efficiency. The value stream is comprised of those specific actions required to bring a specific product (for example, a good, a service or both) through any business' three critical management tasks: problem-solving, information management, physical transformation. This includes achieving specific cost, schedule, and performance targets and, importantly, eliminating waste.[1]

James P. Womack and Daniel T. Jones, authors of *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, observed:

> Our initial objective in creating a value stream "map" identifying every action required to design order and make a specific product is to sort these actions into three categories: (1) those which actually create value as perceived by the customer; (2) those which create no value but are currently required by the product development order filling or production systems . . . and so can't be eliminated just yet; and (3) those actions which don't create value as perceived by the customer . . . and so can be eliminated immediately.[2]

Marvin Runyon, for 10 years the Postmaster General of the United States, has a complementary vision which he successfully deployed in the US Postal Service. Despite the Postal Service's business and, importantly, operational successes resulting from his leadership, he was "criticized for creating too much of a bottom line-driven organization."[3] Runyon responded:

> It's not necessarily the bottom line we're driving at. That is one factor. Employee satisfaction is one factor. Customer satisfaction is another factor. We have three voices—the voice of the business, voice of the employee, voice of the indicator [customer] . . . and we measure all of those factors.[4]

The Air Force has these three voices as well.

While employee indicator development is in its infancy, the effort to develop *customer-focused metrics* was central to a Defense Logistics Agency research project by the same name. This effort applied the Pareto Principle[5] which "states that 20 percent of a given product line or population represents 80 percent of an organization's business and impact."[6] This study found "readiness-driving spare parts tend to have very similar logistics characteristics. They are generally higher demand, higher cost parts, with relatively longer procurement lead times."[7] When combined with improved enabling processes in information technology (IT) and fiscal areas applicable to logistics, this approach can improve warfighter support and satisfaction.

We often cause our greatest obstacles. We do many things, have numerous IT systems and preserve multiple, if not redundant, IT processes past their useful life. Why? Because they were there when we first got here, and now we are comfortable with them—not because they best support future, let alone current operations. Unfortunately, history suggests we are predisposed to the status quo despite being in an environment in which operations, logistics, and business dynamics are moving the Air Force rapidly forward.

> Several years ago, *Reader's Digest* ran an interesting story about a woman who, before baking a ham, always trimmed a small amount off each end of the ham. When her young daughter inquired one day as to why she did this the woman, thinking for a moment, stated that she wasn't certain why, but that she had learned the technique by watching her own mother. She thought it had something to do with making the ham cook more evenly throughout, but she would need to verify this with her mother. When the woman later posed the question to her mother, she was surprised to learn that her mother was not certain either why this was done, but that she likewise had learned the technique by watching her mother, the young girl's great-grandmother. When the occasion arose at a family gathering to ask this question of the great-grandmother, she replied, "The only pan I had available was too small for an entire ham . . . I always had to trim both ends of the ham to make it fit the pan."[8]

Clearly the young daughter needs to stop unnecessarily trimming the ham. Likewise, the Air Force must cease limiting its logistics value stream because its IT enabling processes and tools do not satisfy today's logistics production requirements. Air Force enabling processes need to change at a rate and to an extent necessary to help logisticians deliver increasingly better goods and services to operational customers. As one writer observed:

> Things are moving so fast that if you hold onto your experience too long, you'll get trapped into old ways of looking at things. When you have a paradigm shift, everything goes to ground zero. What does that mean? It's not what you've been taught that matters. It's how fast you can learn. Can you learn faster than the person next to you?[9]

Notes

1. James P. Womack and Daniel T. Jones, *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, New York: Simon & Schuster, 19, 37-49.
2. Womack and Jones, 37-38.
3. Eric Yoder, "Time For Change," *Government Executive: Government's Business Magazine*, May 98, 55.
4. *Ibid*.
5. For an extended discussion on the subject, see *The 80/20 Principle: The Secret of Achieving More with Less*, by Richard Koch New York: Doubleday, 1998.
6. Robert L. St Thomas, Laurence G. Kohler, and David K. Peterson, "Focusing on Weapon Systems," *Loglines*, Vol 4, No 1, 18.
7. *Ibid*.
8. Melissa Chessher, "Executive 2000," *American Way*, 1 Aug 98, Vol 31, No 15, 13.
9. Chessher, 117.

Excerpted and edited from "Transforming Enabling Processes," *Buy It, Move It, Sustain It*, March 1999, Colonel Arthur B. Morrill III.

If we do not acknowledge the urgent need for integrated logistics training, we are placing successful execution of the Global Engagement vision at risk.

Major J. Reggie Hall

Integrated Logistics Officer Training —Do We Have It, Do We Need It, Can We Find It, and How Do We Get It?

Training is not a luxury; it's a necessity!

—Colonel Gary Buis, Air Warrior Commander, 1995

Training transforms an organization's valuable human resources into a motivated and educated work force prepared to perform its mission. Training is connected directly to doctrine, for when stripped away from all its fanciful language, doctrine is quite simply what we believe and, therefore, what we should teach those who follow.[1] This research investigates the link between military doctrine and training to demonstrate the significance of transforming organizational principles, concepts, and beliefs into the corresponding practical and tangible technical training that must equip personnel with the knowledge and expertise to implement strategy and accomplish military objectives.

Expeditionary Airpower

The Need for an Integrated Logistics School

In the Beginning . . . There Was Doctrine

You must teach what is in accord with sound doctrine.

— Titus 2:1

Joint Publication 1-02, *Dictionary of Military and Associated Terms*, defines doctrine as “the fundamental principles by which the military forces or elements guide their actions.”[2] Air Force Doctrine Document (AFDD) 1, *Air Force Basic Doctrine*, defines doctrine as, “A statement of officially sanctioned beliefs and principles . . . what we have come to understand based on our experience . . . fundamental principles that guide actions in support of objectives.”[3] Distilled to the fundamental essence, Air Force basic doctrine is how we fight. Doctrine is the foundation of military capability; it provides the framework for organizing, training, and equipping forces to defend our nation and support our national objectives. The genesis of doctrine lies in the roots of history, for it is from our past experiences and observations that we devise and discern the best practices and most effective means to accomplish objectives.

The synthesis of historical lessons with our expectations and current environmental factors leads to the development of theories that an epistemic community believes and professes to be true based on empirical validation through repetition.[1] The transformation of historical truths and theoretical concepts into codified principles about what we believe and profess becomes sanctioned as doctrine. Doctrine is a growing, evolving, and maturing process that requires a fusion of intellectual vision and practical experience to remain relevant and provide direction for strategic development. The Caffrey History-to-Strategy model shown in Figure 1 graphically depicts the doctrinal development process.

The model depicts the cyclical relationship between experience, theory, doctrine, and strategy; it infers learning and an evolutionary approach to developing strategy. Learning stems from the evaluation of strategy execution in the form of lessons learned from experience. These lessons learned enhance historical knowledge and can be interpreted using the historical record of related phenomena to support new theoretical development. This process, in turn, leads to doctrinal evolution. Professor Matt Caffrey, describes the learning process:

> The lessons learned from experience drive changes in focus areas of importance and training priorities. Doctrinal development is an iterative process, a continuous loop that identifies the salient concepts strategist should build upon and the procedures tacticians should derive and practice in preparation for execution. If doctrine is not driving training, then strategy is stagnant, and self-substantiated dogma prevails.[2]

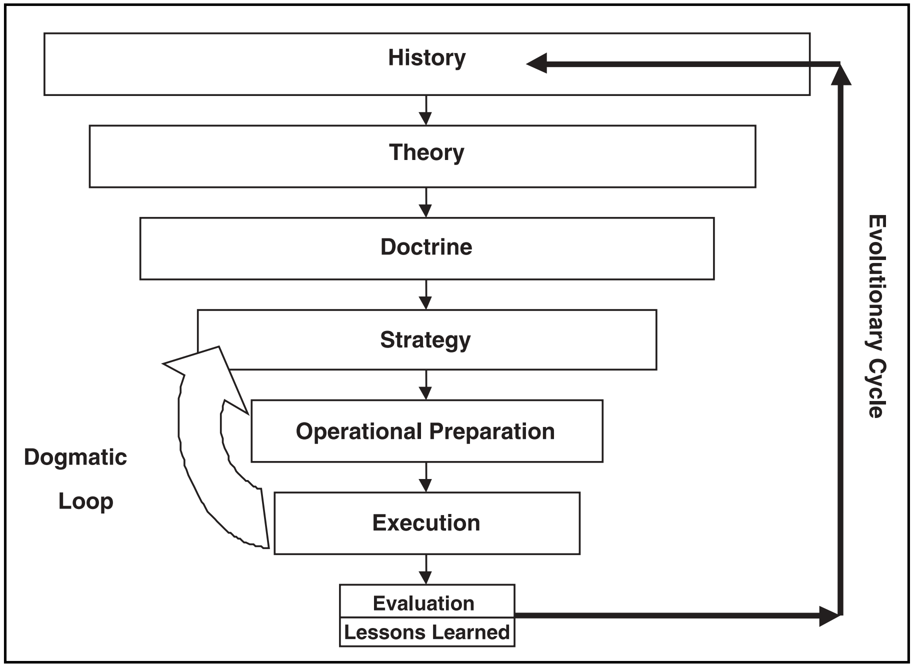


Figure 1. Caffrey History-to-Strategy Model

The Creation of Air Force Logistics Doctrine

The earth was without form and void, and darkness was upon the face of the deep.

— Genesis 1:2

The need for logistics doctrine and logistics officers trained to employ those principles supporting airpower operations is not a new requirement driven by shrinking budgets, Air Force reorganization, downsizing, or the recent shift to an expeditionary force projection strategy. In fact, the search for operational Air Force logistics doctrine and training to develop expert logisticians began before the establishment of an independent air force.[3] The Army Air Corps’ initial attempt at Air Force logistics doctrine was the distribution of a general logistics-planning document, the *Army Air Corps Logistics Manual*.[4] From that inauspicious start, the logistics support element of airpower continued to develop in a reactive, piecemeal fashion based on technical orders and field experience. The difficulty in attempting to apply primarily Air Corps aircraft maintenance practices to the diverse Air Force logistics functions created problems in communicating roles, missions, responsibilities, and combat support requirements to the operators. Leaders in the Air Force recognized this absence of comprehensive logistics doctrine and attempted to fill the void by establishing the Advanced Logistics Course in 1955 at the Air Force Institute of Technology (AFIT) for the main purpose of training logisticians and developing logistics doctrine and philosophy.[5] The course evolved into the AFIT School of Systems and Logistics, and in 1967, a team of cross-functional logistics students took on the task of developing foundational logistics doctrine as their thesis research project. This thesis led to the formulation and 1968 publication of Air Force Manual (AFM) 440-2, *Air Force Logistics Doctrine*.[6]

As time progressed and missions expanded, the Air Force made further attempts to revise and update logistics doctrine in (1) the 1979 version of AFM 1-1, *Air Force Basic Doctrine*, (2) the 1985 AFM 2-15, *Combat Support Doctrine*, and (3) the April 1987 publication of AFM 1-10, *Combat Support Doctrine*.[7] AFM 1-10 stirred heated debate in the logistics community due to the exclusion of the word *logistics* in the title of the logistics source document. This debate proved more than mere semantics as AFM 1-10 encompassed a broader range of logistics functions than before, including nontraditional disciplines such as security, services, and civil engineering, which was more consistent with the joint concept of combat support. Apparently, the Air Force civil engineering and services communities did not consider themselves logisticians, so the title served as a *political* compromise to push the document through to publication and get something out to the field after almost 10 years.[8] The significance of the debate over combat support cannot be overlooked: it reflects an attitude and perception of logistics as a support function or precursor to employing combat power rather than an integrated operational art element available for a commander to influence and leverage combat capability. This separatist notion of logistics as an illegitimate and insignificant bystander in the art of war is epitomized in a German general staff's quote, "Logistics is a necessary evil . . . most often more evil than necessary." That attitude and disdain for logistics requirements would lead to the demise of the German Army through the extended logistics lines of World War II campaigns in Russia and North Africa. Given the historical requirements of sustaining deployed forces and current realties of aerospace expeditionary force (AEF) employment practices, messing and housing deployed forces have been and will continue to be integral elements of expeditionary logistics. The summation of the Air Force journey toward logistics doctrine culminates with the development of Agile Combat Support (ACS) as a core competency of the Global Engagement vision for aerospace power projection. However, the troublesome obstacle of linking doctrine to strategy and training to effectively employ aerospace forces lingers on.

The Development of Agile Combat Support Doctrine

What has been done will be done again; there is nothing new under the sun.

— Ecclesiastes 1:9

Similar to the AFIT interdisciplinary doctrinal development team, although at a much higher level, an integrated doctrine working group—representing a cross-section of Air Force logisticians from the Air Staff, major commands, and the Air and Space Doctrine Center—developed the following ACS definition:

> Agile Combat Support is the cornerstone of Global Engagement and the foundation for the other Air Force core competencies. Agile Combat Support creates, sustains, and protects all air and space capabilities to accomplish mission objectives across the spectrum of military operations. Agile Combat Support provides the capabilities that distinguish air and space power—speed, flexibility, and global perspective.[9]

Following the precedence established in AFM 1-10, the ACS definition expands the traditional scope of logistics consisting of maintenance, supply, transportation, and logistics plans and includes services, civil engineering, and force protection.[10] By definition, ACS has attained equal billing with combat operations as a foundational tenet of aerospace power. What military historians, strategists, and tacticians, from antiquity through the Gulf War, have recognized has been codified in our Air Force doctrine: logistics is a core military operational, art element critical to the successful employment and execution of combat power. As Martin van Crevald states in *Supplying War*, "Although logistics is admittedly an unexciting aspect of war . . . logistics make up as much as nine-tenths of the business of war."[11] During a 1996 presentation at the Smithsonian Institute, General Ronald Fogleman, Air Force Chief of Staff, emphasized the significance of ACS doctrine to airpower. ACS is a vital part of what the Air Force provides the nation; this core competency was adopted to make air forces more expeditionary in nature, so we will continue to be the instrument of choice when national leaders want to engage quickly and decisively anywhere on the globe.[12]

Having garnered the sanctioned endorsement of the Chief of Staff of the Air Force, it would appear that logistics has reached the pinnacle of operational legitimacy in ACS doctrine. Finally, we have a core competency that recognizes the criticality of logistics and focuses on the principles of warfighting doctrine, not peacetime organization. Anchored in sound doctrine, we can proceed with teaching the integrated functions that produce combat efficiency. Unfortunately, we still have the troublesome requirement to align training with ACS doctrine and ensure the concepts we profess as vital to airpower are transferred down in the form of specific tactics, techniques, and procedures developed to effectively implement that doctrine. Historically aligning military doctrine with strategy and training philosophies has been difficult, but nonetheless important, to ensure the successful application of strategy to achieve objectives. In 1915, Commodore Dudley W. Knox described the doctrine-to-training dilemma in the following manner:

> To reach the ultimate goal of war efficiency, we must begin with principles, conceptions, and major doctrines, before we can safely determine minor doctrines, methods, and rules. We must build from the foundation upward and not from the roof downwards . . . . The service that neglects so essential a part of war command as the indoctrination of commissioned personnel is destined to fail in its ambitions for great achievement[13] .

Our aspirations are indeed lofty in establishing ACS as the cornerstone of Global Engagement. These lofty ambitions rely on technological systems capabilities and rest squarely on the shoulders of junior logisticians who must employ ACS functions in a deployed location and sustain combat airpower operations. The path to creating congruency within our doctrine, strategy, and training is contained in the principles of doctrinal congruency and strategic alignment. The road to recovery is paved by adherence to doctrinal priorities in our training methods. While there may be many differences about what doctrine should include and how it should be implemented, ACS clearly provides a comprehensive foundation for educating and training Air Force logisticians for war.[17]

This article will introduce why training is needed to achieve the objectives contained in ACS doctrine and necessary to perform the logistics functions mandated in Air Force Doctrine Document 2, *Organization and Employment of Aerospace Power*, Commander Air Forces (COMAFFOR), Director of Logistics (A-4) responsibilities. An evaluation of the congruency in Japanese World War II doctrine, strategy, tactics, and training philosophy for gaining air superiority in the Pacific provides compelling evidence of the consequences in misaligning strategy, tactics, and training while employing combat aerospace forces to achieve military national objectives.

Integrated Logistics Officer Training—Do We Have It?

> *Tomorrow's logistician must have a much better, more complete understanding of the entire flow of our logistics process. No longer can we afford to build discrete specialists in maintenance, or munitions, or supply, or transportation.*
>
> **—Lieutenant General Leo Marquez, Air Force Deputy Chief of Staff for Logistics, 1985**

Although spoken 15 years ago, the truth of the words above resonates today, for it echoes a fact military historians have recognized throughout the annals of warfare: the mobility and versatility of combat forces is dependent upon the integration of operational logistics functions tailored for combat support. Historically, logisticians have been charged with feeding soldiers (services); providing fodder and fuel for horses and vehicles (transportation); and procuring uniforms, equipment, weapons, and ammunition (supply).[18] The great military strategists, from Hannibal to Frederick the Great to Napoleon, understood the vital link between logistics and campaign success. More recently, US leaders such as Generals George S. Patton, Colin Powell, and Norman Schwarzkopf realized that victory in war is impossible without logistics.[19] The ACS core competency codifies that realization by establishing the basic principles that enable Air Force capability. Regrettably, Air Force logisticians do not normally spend time studying the history of military logistics, and they are not taught integrated logistics concepts in their basic, supplemental, or functional training programs. A historical perspective of logistics officer training at AFIT, the Advanced Logistics Officer Course (ALOC), and functional basic officer courses presents a baseline for comparing congruency between training and doctrine. The historical evolution of logistics officer training lays the foundation for reviewing the alignment and congruency between logistics doctrine and training. An examination of the current logistics operating environment and investigation of data trends and themes collected from survey and interview informants provides a perspective on the adequacy of logistics training in facilitating the employment of doctrinal tenets in the area of responsibility.

Statistical Correlations: Confirmed Relationships on the Absence of Integrated Training

The discussion thus far examined the evolution of logistics doctrine and training. Data analysis provides insights from the experiences of logisticians that have been deployed and investigates the nature of their required duties and adequacy of their preparatory training. The aggregate findings from survey questions targeted at the need for integrated training are presented in this section. The statistical correlations for the remaining research questions are discussed in the subheadings of this section; emergent findings, unsupported hypotheses, and disproved assumptions are presented at the end of this section.

The first correlation significant at the .05 level (.432, n=41) identifying an absence of integrated training is deployed between cross-functional logistics duties and having to *learn on the job* in a deployed location. The data analysis suggests that officers who were required to perform integrated logistics functions in a deployed location had to learn those duties in place. Several noteworthy comments further substantiate the integrated duty and on-the-job-training connection:

- Baptism by fire! Senior leaders expect performance based on rank and level of responsibility. If you don't know how, they expect you to find out how. Little or no time for training!
- There was no logistics training for the deployed environment provided prior to deploying. Everyday was a fly-by-the-seat-of-my-pants experience.
- Couldn't answer detailed questions about composition of munitions packages, hydrant compatibility, flow rates, and so forth. Made several WAGs [wild-ass guesses].

These excerpts from past deployments are consistent with the accounts of recently deployed officers presented later in the text. The *trial-by-fire* analogy also denotes an emergent cultural theme, that of learning on the job without adequate training, as the accepted method of earning professional credibility discussed further at the end of this section.

The second match adequately trained to perform deployed duties and having to *learn on the job* in a deployed location was significant at the .05 level (-446, n=38). Although this negative correlation was expected (if the respondent was not adequately trained, there would be a strong perceived need for on-the-job training), the comments illuminated the breadth of cross-functional requirements and depth of knowledge required:

> As a deployed LG [logistics group commander], I was responsible for vehicle maintenance, operations, and fleet management as well as unit rotations, cargo and passenger movement. My duties also included base supply, individual equipment, fuels, host nation support, and incoming force beddown. One would think that the enlisted force would provide the missing expertise. However, this is a faulty assumption. Case in point, my Pax [passenger] terminal NCOIC [noncommissioned officer in charge], a one deep position, only had household goods experience. Between the two of us, it was a challenge, to say the least, to run the Pax operation.

> I was outside the traditional logistics field. I did support group commander duties and was responsible for billeting, messing, force protection, and MWR [morale, welfare, and recreation]. I was really outside my comfort zone, something I had never done or been trained on.

Data analysis points toward a need for extensive cross-functional expertise and training at a level beyond cursory familiarization or introductory exposure. The dynamic and diverse challenges that deployed logistics officers face are in accordance with ACS mandates and reach outside the traditional logistics boundaries. The relevance of the correlation between the necessity of integrated training and the potential impact on the expeditionary aerospace force (EAF) strategy are examined in the next section.

Integrated Logistics Officer Training—Do We Need It: Connecting ACS Doctrine with EAF Strategy and Tactical Training

> *National security is endangered by an Air Force whose doctrine and techniques are tied solely to the equipment and processes of the moment. Present equipment is but a step in progress, and any air force which does not keep its doctrines ahead of its equipment, and its vision far into the future can only delude the nation into a false since of security.*
>
> **— General Henry H. "Hap" Arnold**

General Arnold's prophetic words have particular relevance when applied to our implementation of ACS doctrine. Although diverse and comprehensive in nature, ACS relies heavily on the exploitation of advances in technology, communications, and information systems. ACS combat capability for future contingencies requires support systems to be *smarter*, needing less maintenance and inventory to reduce the logistics footprint and forward-deploy light, lean, and lethal aerospace power.[20] Much of future logistics relies on the role of information, justifiably so, since information and technology remain paramount to leveraging capability. The fusion of advanced information, logistics, and transportation technologies allows for more precision, flexibility, and responsiveness in supporting and sustaining the warfighter at the point of need.[21] However, a logistics force structure, comprised of skilled and trained people, is absolutely essential to forge the relationships that will produce agile logistics.[22] Information technology is essential for the replacement of mass quantities with velocity and time-definite deliveries, but you must have the capability to integrate those innovations in practical combat application. Advanced technologies alone do not equate to ACS. If you do not have trained personnel who can assimilate, analyze, and respond appropriately using the system technologies to enable combat performance, you have not fully maximized logistics as a force multiplier. Major General William Farmen, USA retired, provides a vivid case in point describing the railway operations in Europe during the early phases of Operation Joint Endeavor:

> Information could tell through intransit visibility where the train cars were on the ground, but without any available railway control teams or specialists, there was [very] little the United States could do to influence deteriorating situations. Information is good, but one must have the capability to act on it.[23]

There is a real danger of becoming enamored with the logistics technological revolution and forgetting the necessity of comprehensive training required for the personnel tasked to employ those systems in combat. That danger increases when the information systems integrate, linking a broad spectrum of diverse logistics disciplines and functions. If we design an interdependent system of technologies as the cornerstone of our combat employment strategy, then we must ensure that system includes adequate training for the airmen employing it in combat. We must ensure that not only are our systems smarter but also our personnel are trained to effectively employ those systems. In her *Air Force Journal of Logistics* article discussing historical perspectives on future military logistics, Lieutenant Colonel Karen Wilhelm suggests that intellectual change is essential:

> The key change, however, must be intellectual change, for without intellectual change, technological change is essentially meaningless . . . . Logisticians who grasp technological change without making intellectual changes to fully understand and make the best use of the technologies are doomed to failure. Intellectual change is the requirement to make all others meaningful.[24]

Intellectual change begins with realistic training. The most effective implementation of ACS in the area of responsibility (AOR) requires integration of technology and cross-functional training for the tactical practitioners.

Statistical Correlations: Confirmed Relationships on the Need for Integrated Training

The data supported the hypothesis that there is a need to better prepare logistics officers to perform the integrated functions they are tasked to employ in an AOR. The first relationship *fit*, "deployed cross-functional logistics duties" and "the Air Force should better prepare officers for cross-functional senior logistics positions," was significant at the .05 level (.564, n=41). Logistics officers who performed integrated logistics duties perceived a need for those integrated skills in future leadership positions and also identified the requirement for additional training. The insight from this connection is the indication that cross-functional development is necessary for logistics officer proficiency in peace and combat.

The second significant correlation identifying a need for expert training in professional development is having to "learn on the job in a deployed location" and "attendance at an expert level school would better prepare me to perform duties in the AOR." Data analysis indicates that those performing integrated logistics duties perceive cross-functional expert training as beneficial preparation. Respondent observations capture the increasing need to grow cross-functional expertise to effectively implement the EAF strategy and the awareness that other services have already addressed the training requirement:

> We are heading for an environment in which captains and majors will be required to know about our cross-functional areas as part of our AEF concept. We will deploy into situations where these mid-level managers will be the senior logistics representatives; they will require *cross-functional* experience long before they become LGs.

Expert schools like the Weapons School draw from the collective wisdom of their best and brightest pilots, to include experiences learned in combat. Students are taught principles and spend hours perfecting them. Obviously, if we had such training in the logistics area, we would be much better off.

Other Service logisticians are not stovepiped. We need at least an operational level of understanding of Air Force logistics.

The accounts of recently deployed logisticians and empirical data presented later in this text confirm the thoughts above. The future is now; junior officers are currently performing cross-functional duties and serving as the senior logistics representative in deployed locations.

Opportunity Costs of Strategic Misalignment—The ACS Doctrine and Training Gap

The survey results and analysis of current logistics officer training programs reveal a gap between doctrine and training. This disparity in cross-functional training is also misaligned with ACS employment requirements. This gap represents an opportunity cost in effective and efficient combat capability. The cost of inadequate training manifests itself in the amount of time logistics officers spend learning on the job at deployed locations instead of arriving in the AOR fully prepared to perform their duties. By realigning training with doctrine, the Air Force can capitalize on the *opportunity* to employ logistics as a force multiplier and eliminate the *cost* of inefficient training.

Organizations are strategically aligned when their vision, goals, and objectives are congruent. Successful organizations have a direct linkage between a well-conceived vision, well-defined goals, and specific objectives.[25] The goals are what we plan to do (rapidly deploy and sustain light, lean, and lethal forces), and the objectives are what we do at the working level to reach those goals.[26] All actions in the process must be properly balanced and support each other; the tactical competencies that determine how and if the goals will be met must align with the objectives accomplished to facilitate success. Steven Semler, noted scholar and speaker on organizational performance notes, "Alignment gives people in the organization the knowledge, capability, or skill [real training] and motivations to perform."[27] If tactics and procedures such as training are inadequate or missing, the steps required to accomplish the vision are incomplete. Gaps in objective support erode the strategic support structure of the overall mission, setting the stage for mission failure. Admiral William J. Crowe, Jr, Chief Naval Officer, commented on the significance of alignment saying, "We usually get the objectives correct, less so the goals, and our vision is usually hopelessly out of date. That is why we win short term but must react to the future."[28]

Air Force strategic misalignment is a slightly different scenario: we have a well-articulated vision and clearly stated goals; however, our methods for obtaining those goals are insufficient. Given the failed historical attempts to develop integrated training and the survey data indicating a training deficiency, it would appear that we are locked in a dogmatic cycle driven by either a denial of the need for training or a refusal to develop training based on prevalent cultural biases. Figure 2 illustrates the development of a dogmatic training cycle in the History-to-Training Model.

This construct, built on the foundations of the Caffrey model, conceptualizes the progression of training from the specific tenets, which are entailed in doctrinal priorities to the broad tactics, techniques, and procedures that are developed and implemented to support that doctrine in combat. Similar to the thinking that leads to dogma in the Caffrey loop, when an evaluation of tactics, training, and procedures training in the execution phase is either eliminated or ignored, learning stagnates. The potential lessons learned are cast aside as an irrelevant anomaly. Cultural or political biases institutionalize the preferred tactics regardless of effectiveness. A historical example of dogma in action is Air Force adherence to strategic bombing strategy, tactics, and training throughout World War II, Korea, and Vietnam irrespective of the impact those activities had on the adversary's will to fight. The urgency of the situation is heightened by the requirement established during the October 1996 Air Force AEF Conference to rapidly deploy tailored force packages anywhere in the world, set up logistics production processes quickly, commence operations, and fly combat sorties within 48 hours.[29]

Everything Old is New Again—EAF: The Return to Airpower Projection

> *The Expeditionary Air Force idea was born of a need to be able to react quickly. It was to get back to the rapid part of deployment. It was something we did very well back in the mid-1950s.*
>
> **— General John P. Jumper, Commander, US Air Forces in Europe**

Just as the search for logistics officer expertise dates back to the Army Air Corps, the EAF concept also is not a new endeavor. While renewed and refocused, it is strongly rooted in the history and traditions of airpower.[30] There are several examples of expeditionary air forces deploying in World War I, such as the British Number 29 Squadron's deployment from Gosport to Dover and Royal Air Force involvement in World War II Operation Torch in North Africa in 1942.[31] In the mid-1950s, the job of the Nineteenth Air Force was to rapidly deploy anywhere in the world, and it did so to places like Turkey, Lebanon, and other *hot spots* around the world.[32] In recent history, the 1996 Operation Desert Strike required immediate response to Iraq with limited aircraft providing a wide range of capabilities to meet the commander in chief's needs. Although the EAF concept was driven by the factors mentioned above, at its core, EAF is about structural change to create a more effective force.[33] Major General Michael E. Zettler's EAF article in the fall 1998 edition of *Exceptional Release* noted:

> Since 1989, which is generally considered the end of the Cold War, the Air Force has drawn down by about one-quarter fewer people, yet our overseas deployment commitments have increased by a factor of four. In other words, only 75 percent of the people we used to have are doing over 400 percent more work than we used to do in terms of deployment[34]

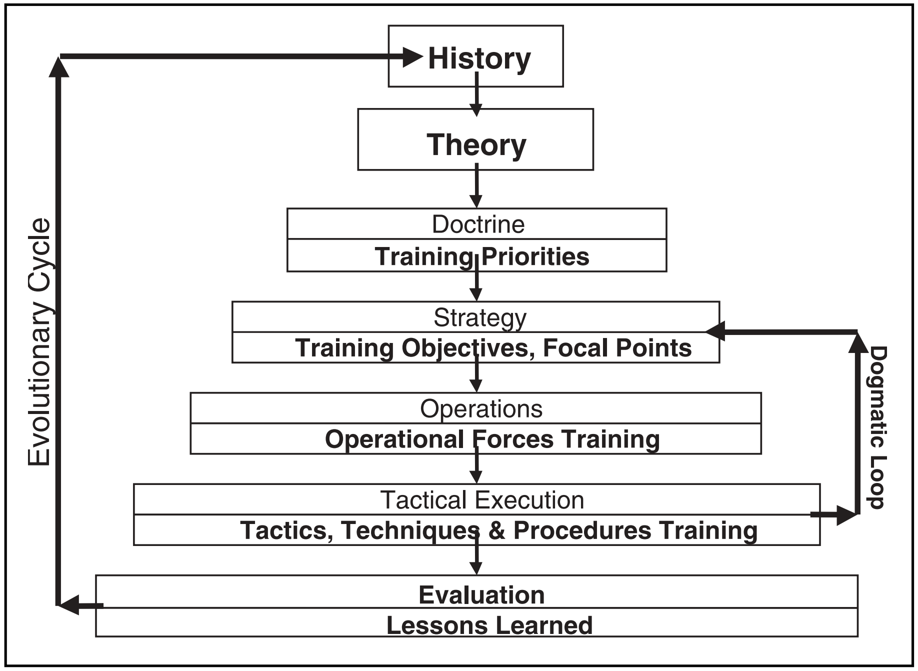


Figure 2. History-to-Training Model

The increased operations tempo and corresponding personnel tempo required to meet the objectives of Global Engagement drove a need to reduce the number of personnel supporting deployments. "Reducing the logistics *footprint* in the AOR to the minimum number of specialists necessary is based on the assumption that technicians have a very good knowledge of what they're doing." Unfortunately, that baseline assumption is wrong; all survey respondents and interview informants with deployment experience deployed to the AOR without cross-functional expertise or training. In fact, it is not rare for company grade logisticians to be responsible for any or all of the logistics functions at a deployed location. Commanding a team of up to 35 personnel covering the broad spectrum of logistics specialties, they are usually the resident experts and senior logisticians onsite during the 120-day deployment.[35] An account from a transportation officer deployed in 1998 to Tuzla AB, Bosnia, as the Provisional Air Base Group Director of Logistics, vividly captures the significance of the current logistics-training dilemma:

> There I was, watching the snowfall, contemplating the upcoming Thanksgiving Day. It seemed that everything was going well at my deployed location, until the storm struck. One of our two aircraft deicers was inoperative, and the snow removal equipment was on its last legs. At the same time, a detachment commander (DETCO) of the Joint Special Operations Task unit was complaining that he still didn't have the bottled water the contracting agent had promised to purchase the day before. Another DETCO is preparing to rent a fleet of rental cars on his own American Express card! On top of that, power production equipment just dropped offline for another unit's mission planning cell, lack of liquid oxygen just became a shortfall for reconnaissance operations, and a C-130 rotator flight still needs to be established here. Critical spares are being held up at customs, and I still don't have commercial airline ticketing capability online. Even though I had vehicle operations, vehicle maintenance, base supply and fuels, traffic management, aerial port, contracting, and civil engineering working for me, I had to figure out how to

> integrate their efforts to get the equipment running, keep the airfield open, and keep all the deployed organizations satisfied with a myriad of logistics concerns. What would have better prepared me for the challenge? An integrated logistics course demonstrating the dynamic and complex nature of providing agile combat support at a deployed location.[36]

Our increased expeditionary operations tempo has served to illuminate a long-existing absence in cross-functional logistics officer training and capability. The effects of manpower reductions and increased operations tempo, combined with the turning away from a containment-focused garrison force to a projection-focused expeditionary force, has exacerbated a preexisting condition, which we can no longer mitigate with massive manpower. Our doctrine substantiates the reality of this requirement. AFDD 2, the Air Force capstone operational document, authoritatively prescribes cross-functional logistics tasks as key responsibilities of the COMAFFOR, A-4 Director of Logistics staff assistant.

COMAFFOR (A-4) Director of Logistics—A Doctrinal Requirement for Integrated Air Force Logisticians

The EAF response to global contingencies requires a fundamental paradigmatic shift in the way we think about, train for, and employ aerospace power. General Michael E. Ryan, Chief of Staff, describes the cultural change and expeditionary mindset shift by saying:

> We are in the process of a significant transition in the way we do business, and this will require embracing a new culture and an approach to operations that emphasize rapid response. The EAF is a fundamental shift in the way we think, and how we organize, train, equip, and sustain aerospace forces.[37]

Air Force operational doctrine formalizes this paradigm and organizational shift in the employment of aerospace power by subordinating Air Force elements within a joint task force under a COMAFFOR. Air and space forces will usually be offered to the supported CINC as a task-oriented, tailored organization called an air and space expeditionary task force.[38] The COMAFFOR A-4 Director of Logistics is responsible for logistics plans, force beddown, transportation, supply, maintenance, food and exchange services, civil engineering, explosive ordnance disposal, and related logistics activities.[39] The A-4's job description mirrors the responsibilities prescribed in ACS doctrine. It appears that at least structurally our logistics doctrine and combat strategies are aligned and congruent. The EAF challenges for ACS require a comprehensive analysis of logistics support to determine how best to meet the warfighter's operational needs. The ability to rapidly deploy a tailored package of aerospace power into the AOR and commence operations immediately requires that logisticians anticipate operational support needs and, in a real sense, know what the warfighters need even before they realize they need it. This prerequisite for new skills and the mental agility to arrive quickly and fight on arrival points toward more realistic training to ensure integrated logistics functions execute rapidly and accurately. The experiences of another young logistics captain deployed to the 31st Air Expeditionary Wing, Aviano AB, Italy, as the Operation Allied Force A-4 provides a good example of the need to be proficient in ACS support functions as resident logistics expert on the COMAFFOR staff.

> Deployed to a provisional airbase squadron as the LG and serving as an A-4 officer on the COMAFFOR staff, I was responsible for contract management, vehicle fleet management, vehicle maintenance, POL [petroleum, oil, and lubricants], TMO [traffic management office], air freight, bio/environmental, civil engineering, base supply, and logistics plans redeployment functions. I learned loads of information through managing each that I would have not learned otherwise. Fortunately, trial by fire worked well for me in each case, but it is not the ideal situation and not a concept we should be comfortable handing to the provisional commanders of EAFs. Working log plans assignments exposed me to several of the functions but, in many cases, did not prepare me for managing most of them. Many of the processes I was responsible for I saw for the first time once deployed. It took a lot of time to become familiar with the functions I was managing. The learning curve was pegged, which made making key decisions affecting logistics outputs difficult. Exposure to these other logistics functions at an agile logistics school could have helped fill the gap.[40]

The initial concept of the operations phase for both the EAF and ACS development highlighted additional training requirements to support EAF strategy and ACS doctrine implementation. A USAF Scientific Advisory Board review of the AEF operational employment procedures suggested that training must shift to an expeditionary emphasis. The advisory board specifically highlighted the need for establishing AEF flag exercise training and minimal maintenance training among others.[41] The board also recommended that the Air Force provide training from classroom to the field that inculcates the AEF philosophy in all members of the Air Force. The ACS Concept White Paper identifies training as required to optimize the capabilities of the force and institutionalize the concept.[42] The white paper also notes that realistic exercise scenarios are essential to maximizing training results, and all ACS elements must be properly represented to emphasize the roles these functions play in the employment of airpower. The Air Combat Command ACS Concept Paper denotes logistics support personnel training requirements for multiple related (cross-functional) skills as well as advanced education and specialty-training requirements to maximize effective ACS implementation.[43] This prerequisite to somehow acquire instant cross-functional expertise becomes paramount in the AOR, where time is precious and every minute wasted learning on the job is a minute closer to mission failure. "If logistics cannot support the sequence of events in the operational plan, it is not a plan at all but simply an expression of fanciful wishes."[44] Failure to recognize the time required to provide logistics support or the delays caused by logisticians understanding and mastering the requirements on the job may force the operational commander to change his plan, which impacts the air campaign or impedes opportunities to exploit enemy weakness. So what does all this mean for the Air Force, what are the potential consequences, and what are the answers to the problem?

Integrated Logistics Training: The Need for Congruency between ACS Doctrine and Training

History has shown that military forces that did not maintain congruency between their doctrine, strategy, and tactics failed in combat. For example, in 1941, Japan had the most experienced pilots in the world, well trained and motivated; they used effective combat doctrine derived from campaigns against China and the Soviet Union.[45] Japan's air and naval air force doctrine was offensive and employed rapid combined operations of fighter, bombers, and reconnaissance aircraft to perform offensive sweeps and close air support.[46] Their strategy was simple, destroy US, British, and Dutch power in the Far East; establish a sphere of influence; and defend the perimeter.[47] Japan was counting on a short war initially, but after the US response to Pearl Harbor, they prepared for a protracted period followed by a decisive naval battle or a favorably negated peace.[48] Meticulous aircrew training was emphasized to hone operational expertise. However, in the drive toward perfection, the pilot production pipeline was extended over 3 years.

As the war progressed, the congruency between doctrine, strategy, and training dissipated. Occupied territories were far too large to defend, and experienced pilots were lost on extensive long-range missions in places far from the center of the empire. By 1944, 90 percent of the pilots with 300-600 hours were lost, yet the aircrew training cycle had not been accelerated to keep up with the attrition warfare strategy. By the end of the war, the experienced factor over the Pacific skies had been reversed, and Japanese pilots (with only 100 flying hours) engaged grizzled Allied combat veterans. Although the lack of Japanese raw materials and industrial capacity was a contributing factor in pilot production, given the inability to produce adequate trainer aircraft, the emphasis on perfection, inflexible training schedules, and lack of surge capability severely hampered Japan's success in the air war.

Similar to the need for congruency between military strategy, operations, and tactics to ensure each level defines the objectives of the next, proper congruency between doctrine, strategy, and training is necessary to support the feasibility of achieving strategic success. Figure 3 depicts this relationship graphically via the History to Doctrine and Training Evolutionary Congruency Cycle. Doctrine and training evolve through the continual application of lessons learned from the most recent history. Those lessons become part of the wealth of historical knowledge, which provides the foundation for doctrinal development. Combining what we know from history with what we believe theoretically codifies the foundational principles and tenets in doctrine. The macro-level training priorities influence strategy development and cascade down in levels of detail through operational objectives and focal points, translating strategic concepts into training required to prepare operational forces for combat. The micro-level TTPs are developed and taught to hone the tactical skills needed for achieving operational objectives in the combat execution phase. Learning occurs as those tactics employed in combat are evaluated and the feedback is incorporated in the evolutionary cycle via lessons learned. The vertical arrows leading from history to lessons learned in both pyramids depict the alignment of TTP training with operational objectives to effectively support tactical employment. The diagonal Z arrows connecting the History-to-Strategy Model to the History-to-Training Model represent the congruency between doctrine and training explained in greater detail via the *Z-Diagram*. AFDD 2 describes the need for congruent objectives and strategies:

> . . . the *Z* figure illustrates the relationship between the objectives at each level. Objectives are normally derived from the next higher level . . . assessment of lower level results lead to changes in higher level history and aligns those objectives with congruent strategic, operational, and tactical training requirements necessary for the

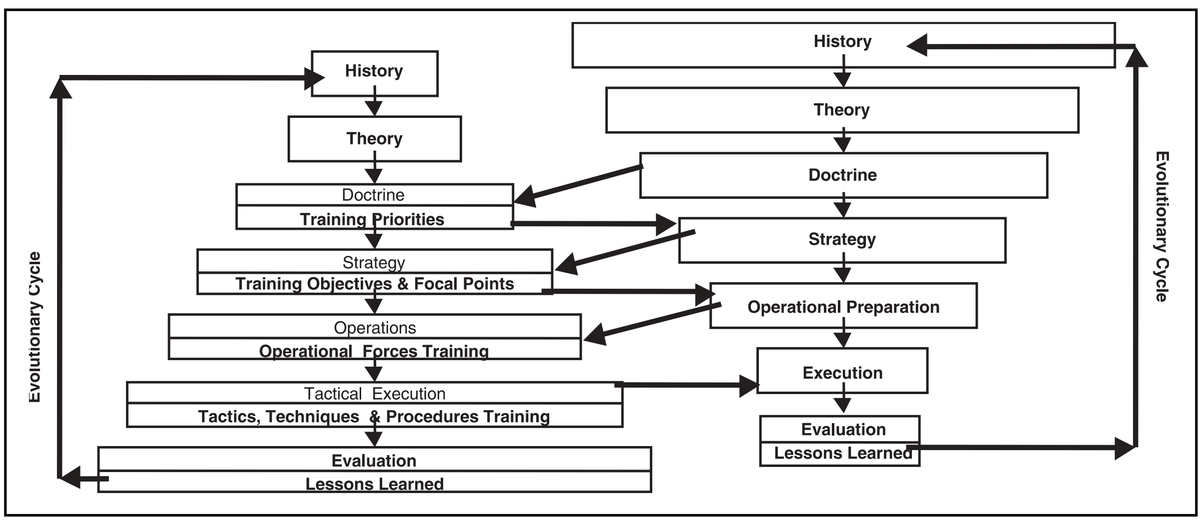


Figure 3. History-to-Doctrine and Training Evolutionary Congruency Cycle

> successful execution of military campaigns, strategies, or objectives.[49]

The History-to-Doctrine and Training Evolutionary Congruency Model captures the significance of congruent strategy, operations, and tactics, chronicled throughout military.

Structurally, our doctrinal foundation and strategy are aligned and congruent. Conceptually, we can illustrate the concurrent evolution of doctrine, strategy, and training to employ combat power. However, logistics officer training, the foundational pillar that supports the entire construct, is out of balance. If ACS is the critical link in aerospace power that we profess and if we truly regard personnel as our most valuable resource, then should we not provide adequate training to support our cornerstone doctrine and airpower employment strategy? A corrective mechanism is needed for establishing congruency to reconcile training with the core competencies and requirements of strategy and doctrine. Where can we locate a benchmark to align Air Force ACS doctrine, EAF strategy, and tactical logistics training? We need to look no further than the origins from whence the Air Force came to find the roadmap—the United States Army.

Integrated Logistics Officer Training—Can We Find It?

> The Air Force is not the only Service that has had threats across the spectrum of conflict . . . . We are restructuring to be a force-projection Army able to rapidly deploy at a moment's notice . . . . Those changes are driven by doctrinal changes in *how* we fight and how we *sustain* the fight—multifunctional support doctrine not only complements warfighting doctrine, it serves as the catalyst for supporting the fight.[50]

Whether it is called the *catalyst* or the *cornerstone*, both the Army and Air Force recognize the criticality of logistics in their warfighting capability. However, the Army has responded to this doctrinal requirement by restructuring its logistics officer training to develop multifunctional logisticians better prepared to support and sustain combat operations. If we truly embrace the heritage of airpower doctrine cultivated into operational strategy and separate tactics, techniques, and procedures at the Air Corps Tactical School, then it is also appropriate to postulate initial EAF logistics officer training using established Army multifunctional logistics training programs. As Army Field Manual 100-5 (FM 100-5) states, "Logistics applies across the full range of military operations at all levels of war."[51] The origins and evolution of the Training and Doctrine Command and the Combined Logistics Captains Career Course are a representative response to changing operational combat doctrine and strategy by aligning corresponding changes in combat support doctrine and training. Data collected from logistics officer's firsthand experiences in deployed locations provide additional suggestions for methods to align training with expeditionary force projection requirements.

Statistical Correlations: Confirmed Relationships on Obtaining Integrated Training

The data analysis uncovered two correlating factors in identifying the means to obtain integrated training. Attendance at an expert-level school would better prepare me to perform duties in the AOR, and a selective expert level cross-functional school would provide a better career path if there were a significant fit at the .05 level (.393, n=40). Respondent observations suggest training as a method to improve performance and prepare logistics officers for combat responsibilities and senior level positions:

- Training adds to the competence and preparation of our officers.
- To be qualified to lead multiple logistics disciplines requires more education than is currently provided.
- It would allow training to mirror the AEF and the tasks required of us as the concept develops.
- Be selective and give those who succeed the opportunity to go to the top.

The data indicating a perceived need for a selective, integrated, expert logistics course combined with the empirical confirmation of the Army's current cross-functional programs suggest that integrated logistics officer training is available.

Integrated Logistics Officer Training—How Do We Get It?

Examining Air Force solutions to pilot combat proficiency requirements as a model for correcting logistics combat training deficiencies is both practical, given our ACS training shortfalls and relevant as a baseline for developing realistic expeditionary employment training for Air Force logisticians.

The data support the benefits of leveraging the legacy of operational training as a pattern for establishing training aligned with doctrinal requirements. A significant correlation .05 (.405, n=35) occurred "at selective expert-level, cross-functional schools would provide a better career path," and "attendance at an expert-level course would better prepare officers for integrated senior level responsibilities." This relationship is predictable (if a training program provides a better framework for career development, then attendance in the course should better prepare an attendee for senior leadership). Respondent comments suggest courses of action the Air Force can take to provide integrated logistics officer training:

- Need more formalized and standardized training for our junior officers. Presently there is too much hit and miss going on.
- The level of information at ALOC is too basic. It needs to be followed up with higher-level information.
- Need a formal, in-residence course providing in-depth analysis of the operational tenets of all logistics disciplines, with focus on the interrelationships among each discipline as well as

core responsibilities associated with the student's future level of responsibility.

Emergent Findings

Thirty-four unexpected correlations emerged from the data analysis. Although the quantity is too numerous to discuss in the text, a few of the emergent relationships are noteworthy. There was a relationship at the .05 level of significance (.525, n= 36) between "attendance at an expert level course would better prepare officer for integrated senior level responsibilities" and the "current logistics crossflow program adds value to the Air Force." Respondents' comments reflect a perception of mitigating or hedging the extent of value added in crossflow training:

- I agree that it adds value; I'm not sure it works in practice. The USAFE/LG told me that she needed a better understanding of transportation during Allied Force. Learning on the fly was difficult and late to meet the needs of the fast-moving operation.
- Expanding the base can aid the participants as well as prepare them for future positions.
- Right now it's the only thing we have that provides practical experience in other disciplines.

Similar to the sentiment of compromise in publication of AFM 1-10 without logistics in the title to expedite getting something out to the field, the emergent theme appears to be that some level of cross-functional exposure is better than nothing at all. Another emergent relationship with a .05 significance (.410, n=41) was selective expert- level, cross-functional schools would provide a better career path and perception of the role logistics plays in the implementation of the EAF. This correlation is somewhat puzzling as it spans peacetime logistics officers' career development and the significance of logistics in warfighting strategy. Respondent comments again provide insight into the perceptions that integrated logistics training is critical in peacetime to better prepare logistics tacticians to employ combat strategy during war:

- For the EAF concept to be successful, it must rely heavily on our ability to deploy and sustain. Training is key. If we don't have log officers who know how to do this, then there will be a steep learning curve when someone gets called up.
- Logistics is still the vital link. My guess is that we will be even busier as we reach across the loggie community to support a myriad of deployments. If we don't have the proper training, each person will have to reinvent the wheel . . . it may get done, but it won't get done right.
- My perception is that "logistics will happen somehow and someplace," a bad way to do our jobs.

Recognizing the criticality of logistics in the viability of the EAF, respondents' perceptions of the gap in training to support the EAF strategy is in line with the findings of this research.

A final emergent theme was respondent cultural and attitudinal perceptions on the value and need for logistics training. Many respondents indicated that valuable learning was only possible via *hands-on* training in the *school of hard knocks*. Lieutenant General John M. Nowak alluded to this mentality in his discussion of changes in career path development: "Officers may be hesitant to leave a familiar environment. However, I believe performance of a leader outside one's comfort zone is a true test of character and leadership abilities."[52] Although adaptability is a key element of leadership, it is disturbing to discover that, culturally, logisticians believe the measurement of professional expertise is in situational survival and not expertise gained through experience combined with training. As Professor Caffrey noted during an interview:

> The notion of creating your experts through *trial-by-fire* rites of passage has been tried by our pilot brethren with catastrophic results. The notion of 'elan as the most critical attribute cost many a French soldier his life in World War I. Ignoring practical training requirements is not only a reflection of dogma, it's just not a smart way of preparing to fight if you want to win the war.[53]

Unsupported Hypotheses and Disproved Assumptions

One of the initial assumptions driving this research was that deployed duties would correlate with the questions regarding adequate training, learning on the job, and the need for integrated training. The hypothesis was that deployed logisticians would indicate a need for integrated training to adequately perform deployed duties. However, there were no significant correlations between "deployment over the last 10 years" and any other factor. The faulty assumption was viewing deployment as an operational mechanism instead of duties. It appears that the requirement to deploy is not a trigger for training evaluations, but the nature of the duties performed in the AOR is. Cross-functional duties and responsibility for integrated logistics functions are an accurate indicator of training adequacy and the perceived need for interdisciplinary training. Additionally, many respondents deployed and performed duties within their primary career field. Those respondents remained satisfied with their level of training. Data analysis indicates that not all deployed logisticians are required to perform integrated duties in a deployed location.

A second assumption was that informants would not view ALOC attendance and the crossflow program as adding value to logistics officer training. However, there was an emergent correlation at the .05 level of significance (.356, n=34) between ALOC "adds value to logistics officer education, training, and development" and "the current logistics crossflow program adds value to the Air Force." Respondents' observations indicate a favorable perception of the value added but a hesitancy to fully endorse the current programs:

- ALOC is a good course but not where it needs to be for cross-functional aptitude, which is necessary.
- ALOC provides some value, but limited.
- Crossflow could be improved.

- Crossflow adds value, but people still have a penchant to identify with one specialty over another.

My assumption that logistics officers would find little value in current career development programs was incorrect. The data revealed a personal bias toward ALOC based on my individual experiences. The *something-is-better-than-nothing* perspective appears to permeate throughout logistics officers' perceptions of doctrine, training, and professional development programs.

Conclusions and Recommendations

> *Logistics and logisticians are always catching up with doctrine. If logistics is to be a success, more emphasis must be placed on logistics earlier in the doctrine cycle. Logistics is not the bill payer, it is the weighted value added for battlefield success . . . . The crux of the problem is that we are without a true azimuth to follow and we don't practice what we preach.*
>
> **—Major General William Farmen, USA, Retired**

Are Loggies Getting the Training They Need?

This research identifies a significant deficiency in integrated logistics officer training. The data reveal a disparity between Air Force ACS logistics doctrine, EAF strategy, AEF operational employment practices, and logistics officer training programs. The Air Force logistics core competency, cornerstone logistics doctrine, and combat strategy remain incongruent and misaligned. Corresponding logistics officer professional development deficiencies caused by the absence of multifunctional logistics training are also identified; logistics officers are not adequately trained to perform integrated duties in deployed locations. The imbalance between our doctrine and training philosophy exposes a fault line originating in the support structure of our Global Engagement vision, continuing through the expeditionary force projection strategy and the logistical tactics, techniques, and procedures needed to employ that strategy. This logistics training fault line lies at the very heart of our EAF strategy, and the tremors resonate throughout our AEF operational employment procedures. We must bridge the gap and align our objectives and strategy with doctrine by maturing combat capability through training and educating logistics officers to employ systems at the tactical and operational levels.[54] Then, and only then, will our espoused doctrine (what we tell the world) and our doctrine in use (what we do to employ that doctrine) be congruent.

If we do not acknowledge the urgent need for integrated logistics training, we are placing successful execution of the Global Engagement vision at risk. The scope of the potential problem is vast; at worst, it undermines the Air Force's ability to effectively project aerospace power and degrades AEF capability. At best, it delays the employment of air campaigns to the supported joint forces commander and degrades the speed, flexibility, and lethality tenets of aerospace power. The potential for disaster is magnified if we do not institutionally train our logistics experts to employ light, lean, and lethal aerospace power in the AOR.

Where Do We Go from Here?

Several logistics officer-training areas requiring further study emerged during this research:

- The Air Force should use the analysis of the logistics officer survey data as an indicator for further investigation into the methods used to *grow, train, groom, and educate* logistics officers. The survey provides a baseline data collection instrument that should be administered to the larger Air Force logistics officer population to acquire and assess logistics officer perceptions.
- The logistics officer cultural values of *rites-of-passage* learning experiences and trial-by-fire training should be investigated to determine if these beliefs are prevalent within the Air Force logistics officer population.
- Existing logistics officer training programs such as the AFIT Combat Logistics course and ALOC should be evaluated to determine if expansion to include integrated logistics curriculum is feasible. Candidate locations should also be identified to incorporate realistic logistics combat employment exercises with course material.

A cross-functional logistics officer training course, modeled after the Army Logistics and Weapons School programs, is recommended as a solution to bridge the gap between logistics officer training requirements and ACS doctrinal principles and AEF employment strategy. A selective expert–level integrated logistics course located at Nellis AFB, Nevada, interacting with the USAF Weapons School and Red Flag, is suggested as the course location. Employment and redeployment aspects of the Red Flag combat exercises offer ideal capstone hands-on training applications and evaluation opportunities for the integration, interaction, and synchronization of integrated logistics training in real world scenarios.

Logistics officers require a broad base of technical expertise, job knowledge, and work experience to meet the demands of senior logistics positions and manage logistics as an integrated and complete process.[55] In essence, enhancing logistics officer competency and performance in combat, as well as logistics officer professional development hinges on developing multifunctional officers to fill multidiscipline jobs across the logistics spectrum in all grades.

> The essential element is training; it is a basic requirement in ensuring our logistics officers are prepared for success. Our current training and career paths do not develop officers for key positions that are multidiscipline and multifaceted.[56]

An agile combat logistics school, such as the course interacting with the Weapons School and Red

Flag programs, would better prepare logistics officers for employing logistics in peace and war. Just as the Weapons School creates the instructors' instructor and builds future operational leaders, the agile logistics school would enable the logistics enabler and prepare logistics officers for the challenges of integrated logistics leadership positions. Figure 4 outlines the proposed agile logistics school course flow and depicts a weapons school introduction and Red Flag capstone exercise. Nellis AFB provides the ideal environment for integrating the realities of integrated logistics requirements and expeditionary constraints in the train-as-we-fight airpower exercises. Creating multifunctional logistics practitioners will leverage the rapid employment of aerospace forces. The Air Education and Training Command is pursuing the agile logistics school concept as the foundation for establishing an Air Force logistics battlelab.

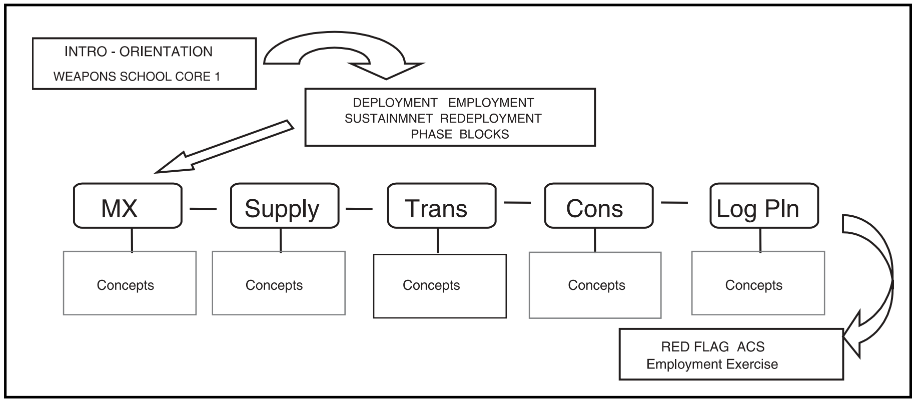


Figure 4. Proposed Agile Logistics School

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To inquire if and where we made mistakes is not to apologize. War is replete with mistakes because it is full of improvisations. In war, we are always doing something for the first time. It would be a miracle if what we improvised under the stress of war should be perfect.

—Admiral Hyman Rickover

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Prejudice against innovation is a typical characteristic of the officer corps that has grown up in a well-tried and proven system.

—Field Marshal Erwin Rommel

Logistics . . . embraces not merely the traditional functions of supply and transportation in the field, but also war finance, ship construction, munitions manufacture, and other aspects of war economy.

—Lieutenant Colonel George C. Thorpe, USMC

Logistics comprises the means and arrangements which work out the plans of strategy and tactics. Strategy decides where to act, logistics brings the troops to that point.

—General Antoine Henri Jomini

The hardest thing to change is organizations that have been successful and to change anyway.

—John White, Deputy Secretary of Defense

The layman tends to associate air superiority with destruction of enemy aircraft . . . it is not the only approach. A potentially vulnerable sequence of events (the aircraft chain) must take place before an aircraft fires a missile or drops a bomb . . . it is possible to eliminate an air force by successful attacks on any point in this chain.

—Colonel John Warden III, USAF

Support System Planning

Under the Expeditionary Aerospace Force (EAF) concept, the Air Force is divided into several aerospace expeditionary forces (AEF), each roughly equivalent in capability, among which deployment responsibilities will be rotated.[1] Each AEF is required to be able to project highly capable and tailored force packages, largely from the continental United States, on short notice anywhere around the world in response to a wide range of possible operations. This concept requires the ability to deploy and employ quickly, adapt rapidly to changes in the scenario, and sustain operations indefinitely. To meet the demanding time lines, units must be able to deploy and set up logistics production processes quickly. Deploying units will, therefore, have to minimize deployment support. This, in turn, demands the support system be able to ensure the delivery of sufficient resources when needed to sustain operations.

To meet these operational requirements, the future combat support system should be designed to maintain readiness levels to support immediate deployments, provide responsive support to deal with unanticipated events, provide support for the full spectrum of potential operations, transition support effectively as the units move along the spectrum of operations (transportation from one kind of operation to another), and be efficient and affordable. Moreover, maintaining readiness to meet potential major theater war (MTW) requirements while a significant portion of the force is temporarily deployed to meet boiling peacetime commitments presents additional support challenges. These challenges differ considerably from those posed by Cold War employment concepts and require a complete reexamination of the combat support system to determine how they can best be met. Strategic Agile Combat Support (ACS) design tradeoff and investment decisions need to be made in the near term to create the ACS capabilities

Logistics Strategic Planning
and Expeditionary Airpower

necessary to achieve the operational capabilities required in the future.

Focus on Strategic Planning

The time horizon over which planning is done determines a number of key planning process characteristics. These include the response time required to construct a plan, level of input detail, and flexibility of available resources. Planning for the ACS system could operate on three different time horizons at the:

- Level of execution (days to weeks): the ACS system should support ongoing operations.
- Midterm or strategic level (months to years): the system should acquire or construct resources to support the current force structure across the full spectrum of operations and in any location critical to US interests, subject to peacetime cost constraints.[2]
- Long-term level (decades): the ACS mobility system and its strategic infrastructure should be modified to support new force structures as they come on line and to utilize new technologies.

A detailed, continuous, careful end-to-end planning process focusing on strategic time horizons is required to develop the infrastructure necessary to transition to the EAF effectively and efficiently. Further, much, if not most, support effectiveness comes from planning and decisions made for these longer time horizons where options include redesigning support equipment, developing support processes and infrastructure, setting up prepositioned resources, and negotiating base access and relationships with coalition partners.

Characteristics of Strategic ACS Planning in the EAF Environment

A strategic ACS planning system for the new environment should assess how alternative logistics designs affect a number of important metrics. These include time lines to achieve the desired operational capabilities, peacetime costs, risks, and flexibility. It should also provide feedback as to how well the existing ACS system meets the spectrum of operational requirements. In comparing the current planning system with the ACS planning requirements for the EAF concept, enhancements should be made in the following areas:

- Supporting the entire spectrum of operations.
- Dealing with uncertainty.
- Evaluating alternative designs for deployment/employment time lines and associated costs.
- Integrating ACS planning among support functions and theaters and with operations.
- Integrating the assessment and development process for technology and policy.
- Controlling variability and improving performance.

Specific Elements of an ACS Planning Framework for the EAF

Based on analysis, the following elements should be considered integral components of an enhanced ACS planning framework:

- A closed-loop strategic ACS planning process to develop alternative strategic designs for the EAF concepts of the future. This planning framework would be provided to the major commands for development of specific area-of-responsibility ACS designs in concert with the warfighting commander in chief's director of operations..
- Use of employment-driven, end-to-end requirements generation models to specify requirements as a function of operational requirements and logistics policies, practices, and technologies for important logistics commodities and processes.
- Use of support options assessment models to compute metrics to compare alternative approaches for satisfying the requirements for individual commodities and processes across the phases of operations—peacetime operations and readiness preparation, deployment, employment/sustainment, redeployment, and reconstitution.
- Use of an integration model to evaluate integrated commodity ACS structures and processes.
- Evaluation of the impacts of uncertainty and alternative transition paths to MTW operations.
- Use of measurements and assessments of actual process performance and resource levels with those that were planned.
- Designation of ACS planning and assessment responsibilities to direct and advocate the strategic system design and evolution.

An integrated, continuous strategic ACS planning process will enable the realization of the full potential of EAF capabilities.

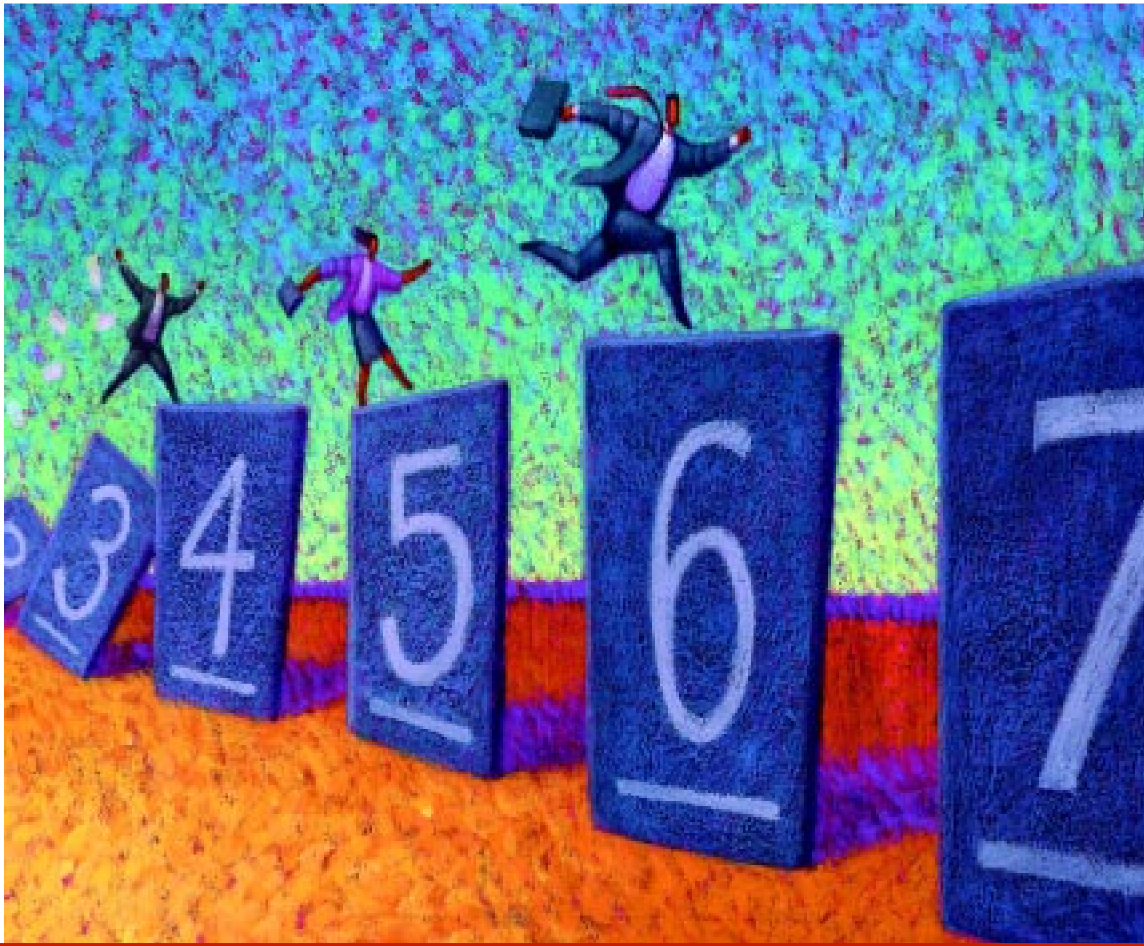
Notes

1. As this concept has evolved, some of the details have been modified. At this writing, the structure consists of ten AEFs as described, including two units for popup contingencies and five AEFs for humanitarian/evacuation operations.
2. The term strategic is used because these decisions are affected by not only time horizons but also the geopolitical strategic situation, technology, and fiscal constraints. As will be argued, these decisions have to be made by complex tradeoffs of risk and benefits using criteria that are strategic in the broadest sense.

Excerpted and edited from "EAF Strategic Planning," *Expeditionary Logistics 2000: Issues and Strategy for the New Millennium*, July 2000, Robert S. Tripp, Lionel A. Galway, Timothy L. Ramey, Paul S. Killingsworth, C. Chris Fair, John G. Drew.

Contractor Metrics

Contractor metrics are best handled if they are included within the QASP in addition to other surveillance methods.



Background

Since 1991, senior federal officials have emphasized performance-based contracting, but recently, they have increased their attention on the approach.[1] This is partially due to the recent attention on using best commercial practices, consolidating requirements, operating within constrained resources, and reducing total ownership costs.[2] For example, the Under Secretary of Defense cited 'the necessity to shift from supply management to supplier management."[3] Also, the *1999 Contracting 21 Business Plan* highlights contract performance.[4] The business plan advocates developing and managing effective service relationships in order to fulfill high expectations.[5] As another example, the Air Materiel Command commander even announced full support to achieve better contractor performance and reduce overall costs through performance-based contracting.[6] Also, a recent interview with the Air Force Civil Engineer addressed the current need to fully support the mission with high quality-of-life levels by maintaining and operating Air Force installations.[7]

Senior officials have also emphasized the business advisor role for contracting officers. The advisors need objective, performance-based, and customer-focused information to facilitate performance management. The business advisor uses this information as a tool to implement the necessary changes for achieving maximum performance.

Within the Air Force, Air Force Instruction (AFI) 63-124, *Performance-Based Service Contracts* (implemented 1 April 1999), features new methods for the business advisors and their teams.[8] The instruction also involves new methods for quality assurance (QA) personnel.[9] The new methods shift from oversight (in-process inspections by random sampling) to insight (validating a provider's management system and process performance metrics) for quality and contract compliance. To facilitate insight, performance-based specifications include measurable performance objectives to encourage contractors to develop innovative solutions and implement cost-effective methods. QA validates the performance objectives' achievement and promotes continuous improvement. With reliance on customer complaints, QA may use contractor metrics in addition to other surveillance methods to measure the contractor's performance quality.[10]

The Federal Acquisition Regulation (FAR) requires contractors to maintain an inspection system for their services.[11] As for acceptance, the Air Force may review the contractor's inspections to confirm contract compliance.[12]

These inspections may provide information to diverse stakeholders. The AFI directs various management levels to provide updates to their higher management level about their services contracts.[13] That is, major command (MAJCOM) directors shall update their MAJCOM commanders annually on the command's service contract program. Duties of a performance management council include assessing the operational effectiveness and Air Force contract management effectiveness, in addition to approving partnership agendas. Contracting squadron commanders shall update their installation commanders twice each year on the installation's contract services program. Duties of a business requirements advisory group (BRAG) include contract performance management (analyzing contractor metrics and evaluating performance for payment and award fees).

Throughout these various reporting levels, performance management centers on identifying problems, providing solutions, and offering approaches toward continuous improvement. Continuous improvement (using feedback to make ongoing adjustments in pursuing a corporate vision) includes information to determine whether or not objectives have been achieved.[14] The partnership communicates to correct or reward those activities and processes which affect achievement toward the vision.

Performance management systems exist to accomplish several other efforts. They may include:

- Demonstrating performance
- Providing information to different stakeholders who have different expectations
- Determining if they have fulfilled certain needs
- Achieving maximum performance within constrained budgets and resources
- Identifying performance level and comparing it to others
- Determining effective resource use
- Setting goals
- Learning through root cause analysis
- Standardizing improvements[15]

Air Force/contractor partnerships require these efforts, and AFI 63-124, *Performance-Based Service Contracts*, allows a new surveillance method: reviewing contractor metrics. This method shifts inspection responsibility to the service contractors and adjusts QA inspection duties with validating those service contractors' quality control plans and promoting continuous improvement. Validation duties include enough surveillance to ensure the metrics portray accurate information. Although new to the Air Force (*AFI 63-124* became effective 1 April 1999), commercial practices have been using Total Quality Management initiatives for quite some time. Still, industry and government organizations incorporate performance management to demonstrate return on investment, benchmark, and facilitate continuous improvement.

Problem Statement

AFI 63-124 offers a unique surveillance approach for Air Force service contracts. The surveillance

for Service Contracts

AFLMA Analysis

Captain Jonathan L. Wright

approach, using contractor metrics, bears the philosophy to provide *insight* rather than *oversight* in order to enhance the quality assurance role. The philosophy also centers on continuous improvement within performance management. Air Force contracting agencies have little experience with this new focus, particularly with using contractor metrics in contract quality assurance. At the same time, functional areas are losing their organic expertise to conduct appropriate surveillance. There is also no current method to consistently evaluate the health of a contracting program.

As a result, the Pacific Air Force Director of Logistics asked the Air Force Logistics Management Agency to develop standardized contractor metrics for service contracts. The Deputy Assistant Secretary of the Air Force, Contracting cosponsored out of concern of evaluating Air Force service-contracting efforts. In response to these requests, objectives identify top-level metrics to determine the Air Force service contracts program's health and provide the necessary service delivery summaries (SDS) and quality assurance surveillance plans (QASP) related to using contractor metrics.

Study Objectives

This project identifies contractor metrics for Air Force service contracts. The study focuses on five major service contracts: *The Big 4* (custodial, grounds maintenance, military family housing [MFH] maintenance, and refuse collection and recycling), plus full food service (and mess attendants). It then includes general metrics for all service contracts. The project addresses the following objectives:

- Providing metrics definitions, the data, and the objective each metric accomplishes
- Outlining rules about getting the data
- Identifying the appropriate data sources
- Creating a service delivery summary and a quality assurance surveillance plan for each service contract

Approach

Interviews that explored a wide range of performance management methods were conducted with commercial and government representatives who have a broad range of facility management responsibilities. Specific attention was drawn to scorecard systems and quality control plans to learn how they best use performance management. After developing contractor metrics for Air Force service contracts, a close review of metric collection and reporting details followed.

This study addresses five service contracts:

- Custodial
- Grounds maintenance
- MFH maintenance
- Refuse and recycling collection
- Full food service (and mess attendants)

These contracts represent the five most common Air Force service requirements: four civil engineering contracts and the full food service contracts. The latter was added due to recent attention in implementing AFI 63-124. Commercial and public service facilities managers also commonly outsource housekeeping, food service, grounds keeping, trash collection, and building maintenance, among other services.[16] The study also provides general metrics for all Air Force service contracts, regardless of the service requirement. The study's metrics are in the SDS and QASP format, which is useful to the contracting officers and quality assurance personnel.

Vision and Strategy

Before raising attention to developing metrics, this study first suggests a vision and strategy for Air Force service contracts. Otherwise, one may create metrics without knowing how they affect a strategic plan. After all, performance management aligns vision, strategic objectives, and performance outcomes, and strategic objectives integrate a business plan's outcomes.[17] The vision and strategy for Air Force service contracts:

> Long-term, best-value service providers, as active Air Force partners, focus on the customer and continuous improvement for maximum achievement, and address Air Force needs while also complying with applicable Air Force instructions and policy directives while also employing best commercial practices.

This vision was suggested with regard to how a partnership conducts performance management. It starts with selecting a best-value contractor, which is the most preferred method of selecting the most advantageous contractor proposal for the service requirement. (*Best-value* techniques employ a tradeoff between proposal merits, the contractor's past performance, cost/price, and proposal risk. Some *best-value* methods, such as performance price tradeoffs only consider past performance and cost/price, but still, the end result is choosing the most advantageous contractor on other factors besides cost/price alone.)

Assuming that the best contractor has been selected, the contract relationship should continue through a typical 5-year service contract length. The vision underscores the need for a partnership in order to address Air Force business plans and goals. The current overarching philosophy is to deem the contract relationship as a partnership. This vision uses the word *active* to reinforce the point rather than considering partnerships as *business as usual*. AFI 63-124 emphasizes customer satisfaction and feedback as well as relying heavily on commercial practices while still complying with Air Force instructions and policy directives.

Performance areas within each service contract were identified to answer what contract requirements achieve this vision. Key objectives were then established to steer these service performance areas toward the vision. For example, these objectives include identifying customer complaint causes, establishing a healthy work-force vitality, promoting safety, and advocating contractor suggestions.

Criteria for Metrics

Several criteria for the metrics were used. One was using effective measurements. In other words, indicators should measure the achievement of goals. Functional representatives suggested or agreed to the indicators. Equally important, the metrics should focus on outcomes and results, not on the process. After all, the contractor bears responsibility for process metrics. The metrics proposed in this study facilitate the business advisor's strategic plan for fulfilling the service requirements. Overall, these metrics demonstrate whether or not one has achieved desired results; they may identify trends, drive appropriate action, and lead one to fact-based decisions. Another criterion was efficiency. Metrics were chosen with respect to the time and effort required to collect, analyze, and evaluate them (cost versus benefit). Finally, the metrics were filtered through the following additional criteria: risk involved in not having the metric, objective priority, contract attention/visibility, and any preexisting requirements to record the data on an Air Force form (the last criterion avoids creating additional work).

The metrics were also limited in number to facilitate a better focus and emphasize their importance. However, too few measures would have the potential to portray an inaccurate performance assessment. In this regard, insufficient information may cause erroneous conclusions. Therefore, the report proposes limited, yet sufficient, metrics.

Some criteria found in Malcolm-Baldridge evaluations for performance excellence for services were also used.[18] These considerations included incorporating new technology, process design, cycle time, key performance measures, and suggestions. Partnership criteria also reflect actionable feedback, targets, minimizing total costs, and a supportive customer role. Therefore, some metrics reflect reasons for customer dissatisfaction, contractor responsiveness to the customer, and customer training.

Outline for Developing Contractor Metrics

This study provides metrics for five specific contracts. Because the metrics are specific to those contracts, the following can serve as a general guideline for developing metric sets as surveillance methods for other types of contracts:

- Develop a vision for the partnership and its performance management.
- Choose strategic objectives that steer specific performance areas toward this vision.
- Conduct appropriate market research and brainstorm as necessary to identify potential metrics.
- Select metrics that indicate how well the objectives are achieved. Using carefully selected contractor metrics along with Air Force (customer)-developed metrics is a surveillance method that can be accompanied with other methods such as customer complaint, periodic inspection, third-party audit, and so on.
- Refine the metrics by soliciting the contractor's feedback.
- Mutually agree on the selected metrics. Writing them into the QASP is a contracting officer's unilateral decision, yet building the contractor's buy-in will promote a more active partnership.
- Collect information for the metrics during a baseline period (the first 3 months). Expect to see a learning curve. Use the optimal portions of the learning curve to create a baseline and then identify a performance target.
- Report the information to stakeholders: senior management, subordinates, and customers.
- Evaluate the selected metrics as necessary and either continue using, further refine, or replace them as necessary. Be careful not to modify/replace metrics just because they are showing unintended results. Also, use customer feedback in validating and/or evaluating metrics. For example, check to see if the contractor's metrics are congruent with customer feedback or customer complaints.

Metric Data

Respondents raised several issues. One concern identified the difference between quality control metrics and those that the Air Force reviews. Related to this issue, they also introduced an argument between Air Force-chosen metrics and those suggested by the contractor. Respondents also offered various opinions on whether or not to link the partnership metrics to an award fee. Other issues included conducting performance reviews, participating in partnerships, explaining the business advisor role, and using customer complaints.

Limitations

The choice of implementation has its tradeoffs of advantages and disadvantages. This study's recommendations do not require modifying a contract or waiting until the next award. Some have perceived that incorporating new metrics into their contract would add costs and/or change the requirements. However, QASPs are not a contractual instrument; they may be changed at the contracting officer's discretion. Further, partnership agreements should allow for flexibility in performance management. For those not having an agreement, BRAG members (with the contracting officer's and functional director's endorsement) may introduce these metrics to their providers, and both sides of the contract relationship may agree to use them. If this is not possible, at least waiting until awarding a new contract introduces the approach at the beginning of the contract relationship.

Results

Market research among commercial firms and government organizations revealed diverse sets of metrics.[19] The diversity represents the link a provider must make to the customer's strategic goals and not vice versa. Because each customer/provider relationship differs, standard metrics were not found except for a common tendency to use employee turnover (churn rate) and safety indicators. As an intrinsic standard, partnerships normally contain a mix of metrics representing results, outcomes, processes, and impact statements.[20]

One debate regards who establishes the metrics—the Air Force or the contractor? One side argues the contractor may tailor the metric set to the business process. The contractor-suggested-metrics argument advocates the contractor's ingenuity and industry knowledge. With metrics already tested and proven to have sustained the contractor in business, this argument underscores how a contractor would avoid additional work (and cost) to meet Air Force-chosen metrics. Furthermore, this argument recognizes the reduced Air Force's quality assurance manpower and, therefore, places the burden on the contractors to develop metrics based on their knowledge in the industry.

Contractors do keep internal metrics—ones related to their resource allocation, processes, and policies. However, these metrics may differ from those chosen by a customer. For example, customers tend to measure whether or not they received services while providers track whether their processes achieved appropriate results (costs).[21] This study does not standardize internal (quality control) metrics; it provides the information tools most useful to the Air Force in order to facilitate a working partnership, continuous improvement, and contractor innovation.

To illustrate the difference between internal contractor metrics and those useful to the partnership, consider the full food-service contract. The contractor maintains many metrics that the Air Force does not necessarily review. A few examples include the budgeted versus actual hours used for the day; average number of breaks per person; and the number of breakfast, lunch, and dinner meals by date for forecasting future resource decisions. The partnership does not necessarily consider these metrics. Instead, they consider overall operation, revenue, and sanitation objectives, to name a few. Therefore, the partnership should consider certain metrics such as a monthly Hennessy program score, monthly earned income (sales), and percent of managers who have not yet received food-handlers training. (The Hennessy program is a third-party audit of all Air Force dining facilities. In this annual contest, each dining facility is rated by a group of experts, and the score reflects the entire scope of the food service program.) These are a few examples of how the Air Force will develop a mutually beneficial performance management plan by selecting the metrics rather than having the contractor select them.

Therefore, BRAG members should use partnership metrics to reflect Air Force priorities in addition to relying on the contractor metrics concerning quality control.[22] The Air Force also establishes the targets—they define the requirements. While contractors may develop their own metrics, the Air Force must develop strategic objectives and link certain metrics to them.

With Air Force-chosen metrics, the partnership has full-picture reporting by using information beyond the contractor's key strengths. The metrics should not report scores on how well the contractors performed according to their core competencies. Air Force-chosen metrics may provide Air Staff and MAJCOMs information as to the service contracts' health and how well the contractors achieved the Air Staff/MAJCOM strategic plans. Contractor-chosen metrics will not fulfill this purpose. Also, with Air Force-chosen metrics, the staffs will have a mechanism to identify areas requiring resources, policy, or success stories. Finally, they allow for benchmarking and its subsequent best practice identification. Targets may compare actual results to the actual last period, budgetary goal, benchmark, or competition.

Implementing Air Force-chosen metrics for a service contract records its *full picture*. Some contractors have used their own metrics to claim full award fees even though their metrics may not necessarily benefit the Air Force. For example, if the MFH contractor set a 5-day standard for change-of-occupancy maintenance and then took 60 days for 20 units (for 3 average days per unit), then the contractor would claim it exceeded the standard. However, without knowing ahead of time, the housing maintenance office did not effectively use the extra time to coordinate external efforts (traffic management flight, new unit tenants, and administrative work). The Air Force would have benefited if the contractor accurately forecasted finishing the change-of-occupancy maintenance, because then the housing maintenance office would have effectively coordinated related efforts. In this example, the contractor would have performed well according to the contractor-chosen metric, but the Air Force did not receive much benefit.

The Air Force should not standardize the metrics. A service partnership demands open communication, problem solving, and continuous improvement between the Air Force BRAG and the service provider. The metrics only provide information so the BRAG can achieve certain objectives. Although standardized metrics may identify the difference between best practices and different practices by reducing ambiguity in performance information, others noted the difficulty in comparing *apples to apples*. For example, one may misinterpret a metric because definitions, standards, and performance levels differ.[23]

Metrics commonly change throughout the contract life cycle.[24] Even with an appropriate initial metric set, new technology, enhanced strengths, emerging trends, or identified weaknesses may require changing it. Metrics also change as providers learn more about their customers. As strategic directions and priorities change, so will the metrics. If metrics need changing, the revised or new metrics must measure success in satisfying the customer's goals.

Performance management consultants recommend against using metrics as an accountability tool and for continuous improvement.[25] Yet commercial firms use metrics for informative and/or for incentive purposes. (Some firms recommend linking the metrics with award fees; otherwise, the contractor will not take the metrics seriously.)[26] On the other hand, some customers use metrics to identify performance strengths and weaknesses and emphasize cost-reducing initiatives. They hesitate to link metrics to the award fees because they may overemphasize some areas and cause unintended consequences. Another challenge may include collecting valid and reliable data (for example, a major problem with Total Quality Management was the *pencil whipping* to achieve *good* scores).[27] One must practice caution if the contractor overachieves in one area while underachieving in other areas.[28]

Interviews also addressed barriers to using performance management systems. Within public organizations, some people noted they lack financial performance measures (having no profit to measure). Other reasons included not having an efficient reporting mechanism in place, fear of knowing the real information about their performance, or lacking faith in an accurate measurement system. The most common barrier was the misperception that using contractor metrics requires more time and effort in addition to the random sampling inspections. Further reasons may include an unclear vision, short-term focus, and inability to link business planning to strategy.[29]

Performance Reviews

In the mutual responsibility of achieving maximum performance, performance reviews promote partnerships through open communication. Agendas typically focus on actual performance, significant improvements, suggestions, budget status, savings, and meaningful action items. With a performance management plan, the service provider should demonstrate historical performance compared with baseline target levels. In some cases, the service provider will identify where they have missed the target. Then they will address concerns and underlying drivers. The service provider also projects future performance levels and issues. The performance review may also include dispute resolution.

Meeting frequency varies within the public and private sectors for each of the five service contracts in this study. Given contractor expertise, risk, management attention, priority, and relevance to the Air Force's strategic objectives, meeting frequency varies from daily to annually. As a general observation, those contract relationships lasting more than 5 years use annual performance reviews to evaluate an award fee. For more specific contract monitoring, quarterly meetings typically answer, what have you done for me lately? During monthly meetings, partners also consider the performance baseline and recommend initiatives for improving performance. Periodic checks demonstrating the customer's attention match the quarterly and monthly meetings. Commercial and public organizations also use daily meetings for task-specific inspections. The best frequency is monthly. Weekly metrics may require more labor than necessary, and quarterly metrics may take too much time between reports.

Partnerships

The contracting officer may require a partnership agreement with the service provider. The arrangement promotes achieving mutually beneficial goals. Their agreement should contain specific goals and their objectives, metrics, meeting frequency, and cooperation. All involved parties sign the document.[30] The partnership commits to specific performance goals and draws the communication lines, responsibility, and dispute resolution techniques. Some Air Force service contracts contain a 120-day walkout clause as a trial feature to allow the Air Force a commercial *termination* feature and the provider a retreat avenue if the contractor cannot achieve the performance levels.

Some contracting officers, contract specialists, quality assurance personnel, and contract managers have stated they anticipate the partnership but have not received direction to use it. If they were directed to establish a partnership, their general consensus rests on having mutually beneficial goals and having several contractors within the same partnership to streamline objectives and efforts.

A Contracting Officer As a Business Advisor

In order to participate as a business advisor during contract administration, the contracting officer (or delegated contract specialist) must address the contractor's performance management. Addressing contractor performance requires a functional knowledge about the contract. It is necessary to understand the contributing factors for each metric. Contract metrics provide information to identify problem areas and strengths. For example, service providers may categorize the complaints in a Pareto diagram, thus identifying those problems requiring the most attention. A Pareto diagram illustrates which category (in this case, which complaint) is most frequent.

The metrics and knowledge about them also assist in identifying best practices. In order to impart practical insight for achieving better performance, the business advisor must first know the objective performance information. By comparing the information to practices with better performance information, the advisor could then better serve the provider with insight. In essence, the business advisor identifies a best (or better) practice. Without performance information, consider how one might label a practice as *best* without any objective criteria to merit the label. In these cases, a *best* practice differs from a *different* practice.

To prevent this, service metrics may offer benchmarking as an added capability to contract surveillance. Benchmarking efforts typically investigate work processes as they compare costs associated with either customer satisfaction or performance levels.[31] These efforts gather best practices, generate new ideas, assist in strategic planning, aid goal setting, provide information for allocating resources, and establish current performance information.[32] Some compare productivity level to service level while also reflecting cost information in order to obtain best practice information.[33] The best practices may focus on opportunities in organization structure, processes, service-level standards, technology, customer-relationship management, culture, skills and experience, and contract management.[34]

In addition to identifying strengths and weaknesses, managers commonly use performance management for accountability, public reporting, and program advocacy.[35] On the other hand, internal uses may include strategic planning, process evaluation, operational control, and performance appraisals. Decision makers use performance management for two main purposes: change management and business management.[36] For changing the business, they track trend data and measure vision accomplishment according to targets. For sustaining business operations, they focus on successes and gap analysis while measuring inputs, outputs, and outcomes. Either way, the Air Force shares the outcome's success or failure.

Customer Complaints

For sufficient feedback, surveys must show reasons for customer dissatisfaction. However, most customers do not complain or express their satisfaction or even dissatisfaction.[37] Additionally, most firms use quarterly or annual customer feedback surveys, thus leaving the customer much time to reconcile the complaint before responding to the survey.[38] At best, some firms monitor customer complaints at least monthly.[39]

Therefore, measuring the total number of complaints may cause misleading analysis. This information does not indicate why respondents are complaining; therefore, this indicator does not effectively support the customer-focus objective. Also, in considering the total number of complaints, one may expect an initial spike (the first month) and subsequent spikes when one encourages facility managers to use the complaint system. Besides, providers typically receive a low response rate. Further, QAs and facilities managers mentioned having *complaint burnout*. They complained about problems in the past without resolution and will not likely complain again. Therefore, using only a total-number-of-complaints metric would cause more questions than answers. Rather, the business advisor should consider the underlying cause and strive to prevent recurring complaints. Essentially, the customer complaint provides data to learn more about customer needs and expectations—not an achievement score.[40]

In addition to identifying the provider's problem areas, customer complaint systems should begin concentrating on the customer. A high number of nonvalid customer complaints recurs for each service contract in this study. For example, the facility manager complains about cleaning services not performed on Tuesday, when the custodial contractor was required to clean on Wednesday. In this regard, the customers do not know (or remember) the service delivery summary for their facilities. As nonvalid complaints could represent a problem area, QAs have indicated their preference to quantify the percentage of nonvalid complaints of the total complaints received.

The Traditional Air Force Customer Complaint Process

For unacceptable services, a base employee, MFH resident, or QA may initiate a customer complaint. Once notified, the QA fills out an Air Force Form 714, Customer Complaint Record. A complaint is valid once received and documented on the form. The QA informs the customer of the approximate time to correct the defect. (The customer must notify the QA for uncorrected defects.) Then the QA forwards the complaint to the contractor's quality control inspector (QCI). The QCI may disagree with the complaint after inspecting the site. If so, the QA inspects the defect and then notifies the customer for nonvalid complaints. If the QA identifies a valid complaint, the QA notifies the QCI to correct the defect. Then, the QA documents the incident as a QCI's failure to recognize a valid customer complaint. The QCI returns the Form 714, complete with the actions taken, to the evaluator who files the complaint for future reference.

Data integrity, a primary concern, becomes suspect when the customer-complaint system includes more layers in the complaint-handling and review process. People may act as filters, which may reduce the number of complaints, change the complaints from the original cause to an assumed cause, or even delay the total response time to the complaint. Automated reporting (an intranet) allows easily accessible data and reduces the number of filters involved in forwarding information.[41] Therefore, these systems reduce decision time while providing the necessary information.[42]

A Revolutionary Customer Complaint Approach

As a means toward reducing the number of nonvalid complaints and providing more efficient communication to the contractor manager, one installation automated its custodial and refuse collection contracts with web-enabled technology. A hyperlink from the installation's homepage provides facility managers information such as their facility's SDS, service frequency, and each task's service level. The site also contains a form for entering customer complaints. This form facilitates the customer complaint because the customer actually chooses from a predetermined complaint list for the appropriate cause of customer dissatisfaction; the customer may also enter comments. Once the customer submits a complaint, the QCI automatically receives the information into a database for quality analysis. This automation eliminates those complaints from the civil engineering customer-service desk and QA workload. The service provider does not need to spend extra time collecting customer complaints and synthesizing the results into a report—the web site updates complaint information with each new incoming complaint. Therefore, the QA and contract specialist still have the necessary performance information provided to them in order to provide insight toward continuous improvement.

Changing the Surveillance Approach

Because AFI 63-124 has only been implemented since 1 April 1999, some contracts are still compliant with Air Force Manual 64-108, *Service Contracts*. Therefore, contracting officers have several options in implementing new surveillance methods (contractor metrics). Table 1 shows several options and their advantages and disadvantages.

Performance Penalties

QA personnel raised a common concern: with contractor metrics, what happens to performance penalties and contract discrepancy reports (CDRs)? They still have the avenue of having the contractor reperform the service (otherwise, not paying for that particular service). Also, they still have the option of documenting CDRs for justifying whether or not to exercise an option and past performance information for future source selections.

One contractor manager perceived the contractor metrics as a means toward reporting defects and, thus, automatic CDRs. The QA personnel addressed the issue by underscoring the importance of their partnership rather than focusing on whom to blame for their faults. The contractor was then willing to provide metrics at no cost. Besides, as the contractor mentioned, a performance deduction threat is not necessarily a motivator toward achieving maximum performance.

Conclusions

The metrics are tools for identifying problem areas, benchmarking, and further researching best practices. Metrics are well suited for recognizing and advocating the contractor manager's power to motivate line employees toward continuous improvement.

The metrics do not achieve maximum performance. The contractor line employees, contractor managers, QAs, contracting officers, contract specialists, quality assurance program coordinators (QAPC), functional commanders, and contracting squadron commanders achieve it. Together, they make the performance management team. They should determine the metrics through buy in and tailor the metrics according to the Air Staff's or MAJCOM's strategy. They should also allow the metrics to evolve as necessary. The following

Option	Advantages	Disadvantages
Wait Until New Award; Incorporate as Contract Data Requirements List (CDRL)	• The CDRL is an easily identifiable list of required reports (for example, metrics). • Offerors may provide comments on a draft. • Offerors may build the costs into their proposal.	• Evolving metrics require further contract modifications. • Contractors may submit cost claims for changes in metrics. • Waiting until awarding the new contract may last as long as 4 years.
Wait Until New Award; Incorporate as part of Quality Assurance Surveillance Plan	• Stipulates/ensures receiving metrics from the start of contract performance. • Offers *change* flexibility. • Offerors may provide comments on a draft. • Offerors may build the costs into their proposal. • Contractors do not submit cost claims for changes in contract surveillance.	• Waiting until awarding the new contract may last as long as 4 years.
Modify Existing Contract	• Faster implementation than waiting for the new award. • Stipulates/ensures receiving metrics.	• The contractor may submit a claim for additional work. • Evolving metrics require further modifications. • Cost may exceed benefit if the contract is in its 3d or 4th year.
Incorporate into Partnership Agreement	• Fosters partnering. • Offers flexibility. • Contractor *agrees* to the surveillance technique. • Faster implementation than waiting for the new award.	• One may not exist for that contract; however, perhaps it is time to create one. • May lack contracting officer's unilateral decision. • May be a weak a surveillance method.
Introduce as Performance Review Agenda	• Quick implementation. • Fosters partnering. • Offers flexibility. • Contractor *agrees* to the surveillance technique.	• Does not ensure you will receive the information. • May lack contracting officer's unilateral decision. • May be a weak surveillance method.

Table 1. Contractor Surveillance Methods

questions are useful in determining which metrics to select:

- What priority am I serving in using my time for this metric?
- Why should I take the time to collect and report the metrics?
- How does this help me in my daily operations as QA, dining facility manager, or solid-waste manager?
- How will I have the authority to act or make decisions according to these metrics?

In terms of measuring the service contract's health and focusing attention toward continuous improvement, the performance management team should treat the recommended metrics as a baseline to facilitate the change. Within this team, functional directors and their QAs may offer better indicators or have different objectives or performance areas. They may also require receiving more metrics demonstrating their contractors' own quality control systems. Metrics will evolve as personnel actively use, further develop, and refine them to solve problems. The functional customer may or may not desire to automate the customer complaint system.

Contractor metrics are best handled if they are included within the QASP in addition to other surveillance methods. A baseline should be established during the first several months, and a performance target may be identified. This considers the transitory nature of having never collected the information to building it into the contract as a performance requirement. Using contractor metrics requires other complementing surveillance methods to validate performance. Although using the contractor metrics will save time compared to the random sampling approach, the metrics cannot capture every contract requirement.

Reviewing the recommended metrics at least monthly, if not otherwise noted, is best suited for the performance management team. Weekly (or even biweekly) metrics may require too much labor and attention. Quarterly metrics may lose their ability to affect change because of the time delay.

Recommendations

- Provide the service delivery summaries and quality assurance surveillance plans to the QAPCs at all operational contracting squadrons. The QAPCs should consider using the metrics as a tool for identifying problem areas, benchmarking, and further researching best practices.
- In terms of measuring the service contract's health and focusing attention on continuous improvement, treat the recommended metrics as a baseline to facilitate the change.
- Allow installations to use the metrics and modify accordingly to suit their installation's mission and objectives. Do not standardize these as contractor metrics.

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Logistics Stuff

Five Things to Consider

The operations/logistics partnership is a target for our enemy—protect it. We must try always to think of an enemy's looking for the decisive points in the partnership. What we want to make strong, they will try to weaken. Where we want agility, they will want to paralyse us. What we can do to our enemy, we can do to ourselves by lack of attention. So all concerned with operations and logistics must protect and care for the partnership and the things it needs for success. This includes stuff and information and people. Also, we must not forget the corollary is just as important: the operations/logistics partnership of the enemy is a target for us; we must attack it.

Think about the physics. Stuff is heavy, and it fills space. Anything we want to do needs to take account of the weight that will have to be moved, over what distance, with what effort. Usually this all comes down to time, a delay between the idea and the act. If we think about the physics we can know the earliest time, we can finish any task and we can separate the possible from the impossible. It is crucial to determine the scope of the physical logistics task early in any planning process. Planners must know how long things take and why they take that long.

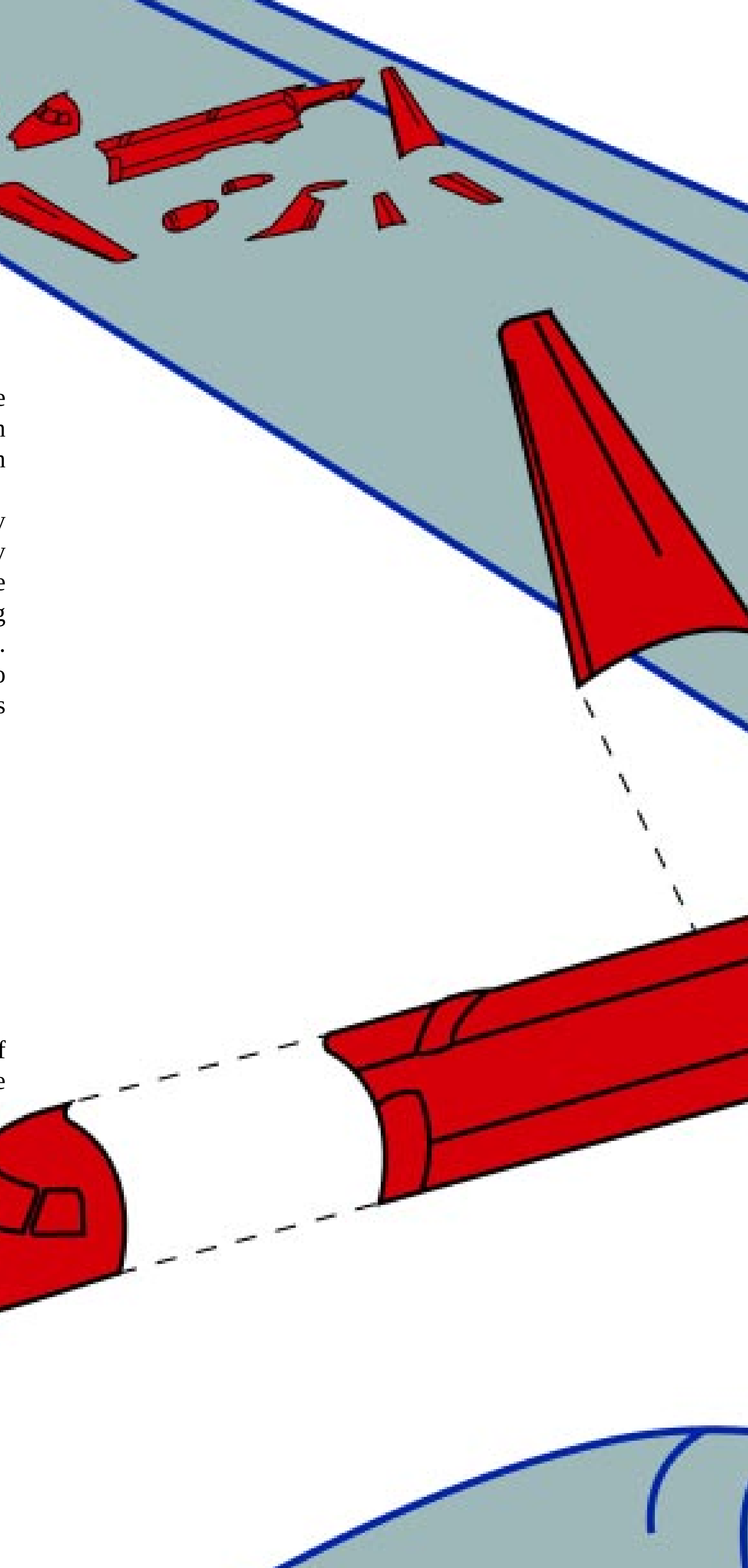
Think about what needs to be done and when—and tell everybody. Once we have given instructions and the stuff is in the pipeline, it will fill that space until it emerges at the other end. The goal is to make sure that the stuff coming out of the pipe is exactly what is needed at that point in the operation. If it is not, then we have lost an opportunity—useless stuff is doubly useless, useless in itself and wasting space and effort and time. Moving useless stuff delays operations. Also, priority of order of arrival will change with conditions and with the nature of the force deploying. For example, the political need to show a presence quickly may lead a commander to take the risk of using the first air transport sorties to get aircraft turn-round crews and weapons into theatre before deploying all the force protection elements.

Think about defining useful packages of stuff. Stuff is only useful when all the pieces to complete the jigsaw are assembled. Until the last piece arrives, there is nothing but something complicated with a hole in it. It is vital to know exactly what is needed to make a useful contribution to the operational goals and to manage effort to complete unfinished jigsaws, not simply to start more. Useful stuff often has a *sell-by* date. If it arrives too late, it has no value, and the effort expended has been wasted. The sell-by date must be clear to everyone who is helping build the jigsaw. And it is important to work on the right jigsaw first. In any operation, there is a need to relate stuff in the pipelines to joint operational goals, not to single-service or single-unit priorities. It is no good having all the tanks serviceable if the force cannot get enough aircraft armed and ready to provide air cover or ensuring that the bomber wing gets priority at the expense of its supporting aircraft.

Think about what has already been started. The length of a pipeline is measured in time not distance. There will always be a lag in the system, and it is important to remember what has already been set up to happen later. Constantly changing instructions can waste a lot of energy just moving stuff around to no real purpose. Poorly conceived interventions driven by narrow understanding of local and transitory pain can generate instability and failure in the system.

Group Captain David J. Foster, RAF
"Fightn' N' Stuff"
Logistics on the Move

Reducing Base-Level Excess AWP Items



Background

In 1999, the Air Force Supply Executive Board (AFSEB) expressed concern about end items in awaiting parts (AWP) status at base level—excessive AWP items and items remaining in AWP for long periods of time.[1] Implicit in this concern was that the Air Force Materiel Command (AFMC) repair prioritization system was not effectively repairing the parts (shop replaceable units—SRU) needed to fix the end items (line replaceable units—LRU).

Discussion

Quantifying the Number of AWP Occurrences

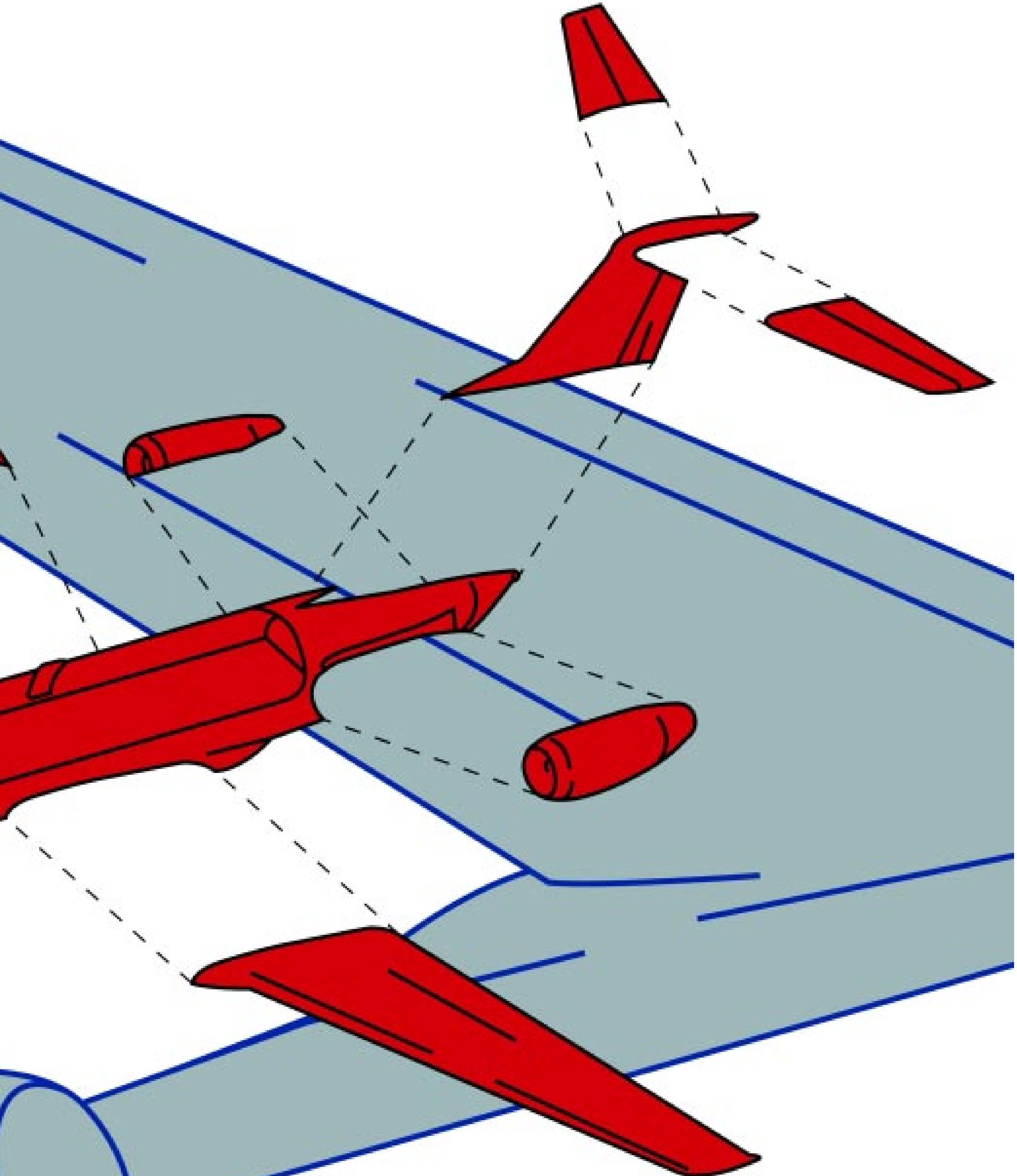
Using a 13 August 1999 Execution and Prioritization of Repair Support System (EXPRESS) database snapshot of Stock Control System data, the number of AWP occurrences existing at that point in time was estimated.[2] EXPRESS does not have explicit visibility of end-item AWP, so it was inferred from base due in from maintenance (DIFM). Later analysis by Air Combat Command (ACC) confirmed that 85 percent of DIFM are AWP. For the 13 August snapshot, there were some 15,750 AWP occurrences. Subsequent snapshots in time have resulted in essentially the same numbers.

Next, the AWP occurrences were stratified into three categories. These categories were used in order to aggregate the occurrences that required the same or similar management actions.

Before reviewing the three categories, one point needs to be made. In terms of this study, *excess* is defined to mean assets exceeding the base requisition object (RO) (base excess) and exceeding the sum of all the bases' ROs for worldwide excess. These items are not excess in the sense that they are excess to the total Air Force stockage and retention needs. The on-hand levels at the bases are well within Air Force retention levels.

AWP Items within the Base RO. This category includes all serviceable on-hand assets plus any due-ins, plus DIFM, to include all AWPs that were less than the base authorized level, including peacetime, readiness spares, and additive levels. The end items (LRUs), in this case, are needed to fill an authorized level at that base. Component SRUs must be repaired to ensure sufficient availability of subcomponents to fix enough LRUs so that the authorized level is obtained. There were 5,836 AWP end items in this category, roughly 37 percent of the total.

AWP Excess to the Base RO but within the Sum of all Base ROs. These are items that are needed at another base and are excess to the authorized level at the base where they are located.



There were 2,354 occurrences in this category, roughly 15 percent of the total. Since the current AFMC repair prioritization system looks at only one base at a time in order to determine the repair force need, the Air Force could (and should) provide the component parts to repair the AWP end item.

Items Excess to the Base and Worldwide RO. In this case, the end item is not needed. All authorized levels are accounted for: serviceable on-hand, intransit, or other items being repaired in DIFM are available to meet authorized levels. It is not clear that the Air Force should repair the component parts to fix any of these items.

Analysis and Management Action Proposals

AWP within the Base RO

AFLMA Analysis

Captain Wesley E. Manship, Jr

For the August 1999 snapshot, there were 5,836 AWP occurrences within the base RO. Two key questions are: Why are there so many? Is there a bias in the AFMC repair prioritization system (EXPRESS) that prevents or delays providing the SRU component parts to repair the AWP end item?

For mission-capable (MICAP) and other customer due-outs, the base requisitions both the LRU (end item) and the SRU (component recoverable items) for AWP occurrences. Pure EXPRESS logic prioritizes the SRU higher than the AWP LRU. That is, EXPRESS sees it as cheaper (less repair cost) for the depot to repair the SRU in order to fix the LRU at the base than to repair the LRU at the depot. One would conclude that there is a bias to fix SRUs. However, there are two situations that can prevent pure EXPRESS logic from repairing the SRU.

First, EXPRESS may not always link the SRU to the LRU in AWP status. EXPRESS uses the AFMC Application and Indenture File to link AWP requisitions (6L advice code) to the LRU end item. As a result, EXPRESS does not have information to link a specific SRU to a specific LRU AWP occurrence. Further, *dirty data* can prevent an accurate LRU-SRU linkage.

Second, the Air Force modified EXPRESS to prioritize certain requisitions differently (higher categories) than pure EXPRESS logic. The Spares Priority Release Sequence, SPRS, (previously called the Board of Logistics Advisors [BOA] release sequence) prioritizes certain project-coded requisitions (Joint Chiefs of Staff coded, MICAP items, and items with project code 700) into special higher categories that override EXPRESS logic. For these items, EXPRESS would not assign the SRU the special SPRS priority but, rather, the pure EXPRESS priority the LRU would earn. In these, as well as most other cases (more than 70 percent reparable item due-outs are MICAPs that receive an SPRS priority), modified EXPRESS was biased toward repairing and providing the end item and not the SRU (component part).

Recently, the AFSEB approved changes to address these two issues. First, they approved an AWP reporting system to link SRU component requisitions to the specific AWP LRU occurrences (not just to a LRU). Second, the AFSEB approved and AFMC implemented a change to EXPRESS (EXPRESS 3.1) that assigns SPRS priorities to SRUs for AWP occurrences. Specifically, EXPRESS 3.1 assigns the LRU SPRS priority to the SRU and maintains an SPRS priority for the LRU. However, the LRU priority is a lower *pseudo*-SPRS category than the project code on the LRU (that was assigned to the SRU). In essence, EXPRESS 3.1 removes the bias against the SRU repair, thereby reinstating the (original pure EXPRESS) logic of prioritizing the SRU repair higher than the AWP LRU.

Presently, AFMC is measuring the performance of EXPRESS 3.1. Figures 1 and 2 provide the metric results of the AFMC effort.

Figure 2 shows a side-by-side comparison of two EXPRESS runs using the same data: one *with enhancement*, where the AFSEB-approved changes were made, and the other *without enhancement*, where the changes were not made. The graph shows the percent of total depot repair hours that EXPRESS recommends be spent on SRUs in priority sequence. The vertical line represents the point on each prioritized list where the BOA priorities end (about 70,000 depot repair hours). This is significant because the AFSEB-approved enhancement only impacts BOA priorities. The graph also shows that within BOA priorities enhanced EXPRESS will prioritize SRUs more accurately. Graphically, this illustrates that the AFSEB changes have had the desired effect on EXPRESS priorities.

Figure 2 also demonstrates the real-world effect of these changes on customer support. Specifically, the bottom two charts show that base AWP and LRU DIFM for EXPRESS items decreased from the time the change was implemented (May 1999). Further tracking of these measures shows a similar trend.

AWP Excess to the Base RO

Today, EXPRESS prioritizes the SRU as it would prioritize the LRU *at that base*. Since the LRU is excess to the base RO, EXPRESS prioritizes the SRU (and the LRU) with a relatively low priority. The logic seems correct for that base, but what if the LRU is needed at another base? Would it not be in the best interest of the Air Force to provide the SRU (the cheaper repair) to the base and laterally ship the (repaired) serviceable to the base with the need? Clearly, that is a more efficient way to meet Air Force needs than for the depot to repair an LRU (assuming there is a carcass at the depot) and leave the reparable LRU at the AWP base.

This can be illustrated with the following example.

Base A: RO = 10, Serviceable = 8, AWP = 6

Base B: RO = 10, Serviceable = 0, AWP = 0

The EXPRESS priorities to provide components for the six AWP at base A is relatively low, but four of the AWP priorities will be very low (probably never be repaired) because they exceed the base's RO. In fact, EXPRESS would cap the last four LRU requisitions

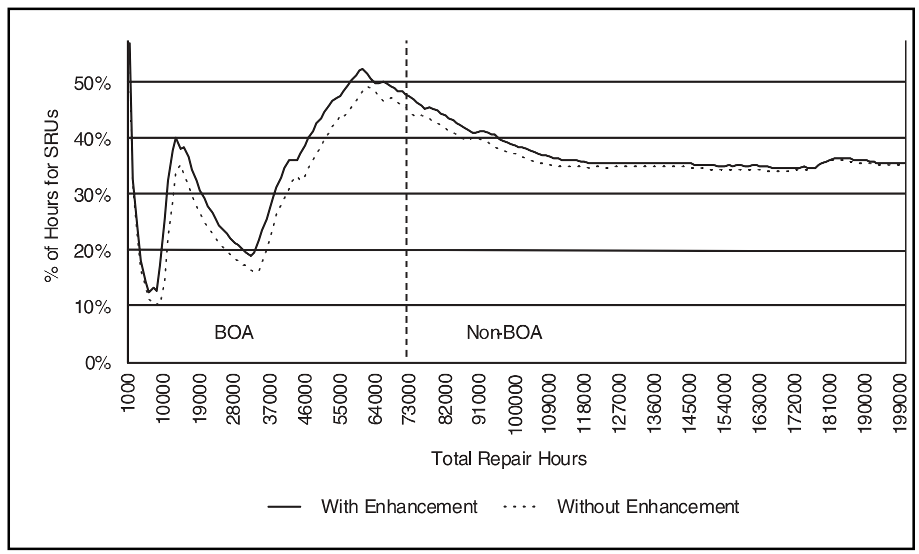


Figure 1. Impact of SRU Enhancement in Express 3.1

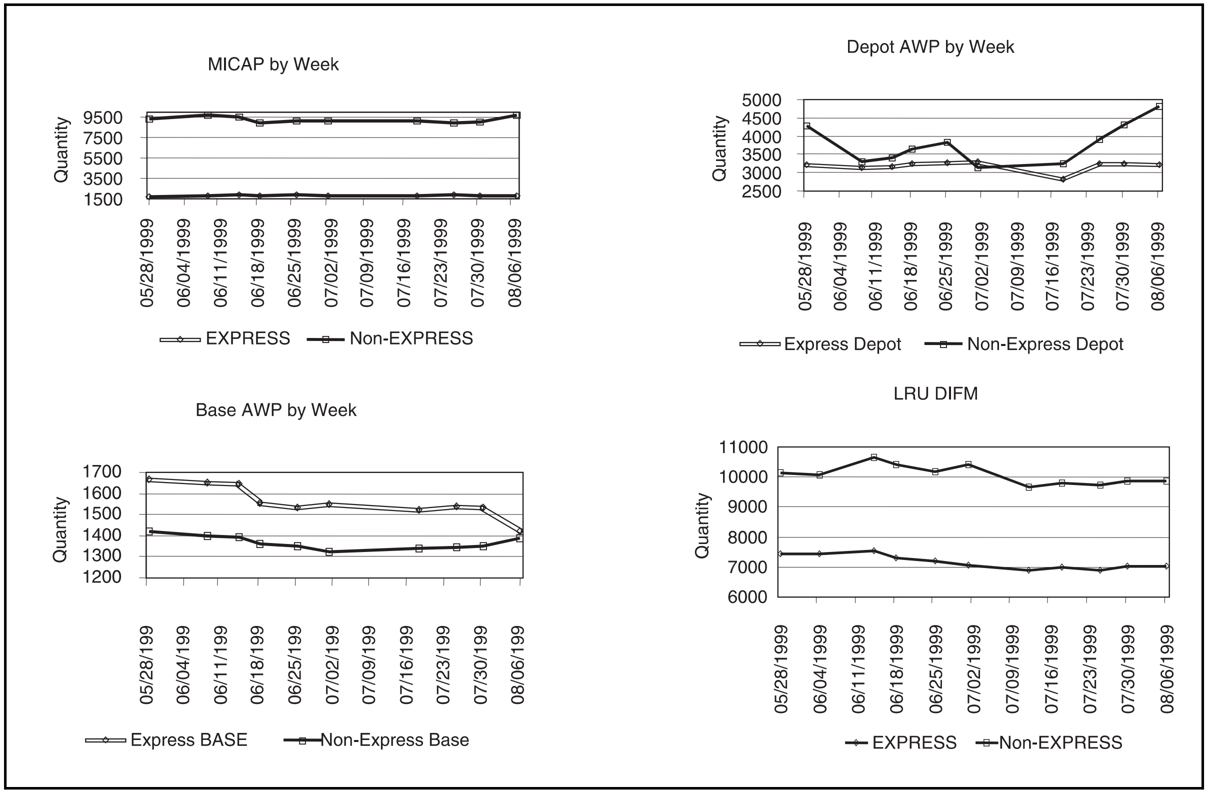


Figure 2. EXPRESS Metrics

(if they were requisitioned). However, base B would have a relatively high priority for the LRU. EXPRESS today has no way to assign base B priorities to the SRU requisitions at base A.

What then are the ways to give priority to the SRU at base A, as if the AWP condition existed at base B? That is, instead of the depot fixing an LRU that would be sent to base B, EXPRESS would provide an SRU to base A to fix the LRU and send the LRU to base B. Since this approach depends on movement of assets (either lateral resupply or redistribution) between bases, additional analysis was performed to determine if these movements alone (shipping a serviceable from one base to a base with a higher need) would improve support and thereby increase EXPRESS priorities for SRU repair. The analysis used AFMC's Supply Chain Operational Performance Evaluator simulation model with actual EXPRESS data. Table 1 provides the results of this analysis.

Current supply policy directs that items be shipped laterally to correct MICAP conditions and achieve 73 percent availability. Note that laterals improve support over those cases with no lateral shipments allowed (from 65 to 73 percent). If lateral shipments were allowed to replenish stock for zero balance conditions (like base B above), aircraft availability increases to 78.7 percent. Up to the last entry in Table 1, we assumed only lateral support actions with no changes to EXPRESS. That is, we would ship one of the eight serviceables from base A to base B. For the last entry, base A was provided the SRU component and then shipped laterally the repaired LRU (the ninth serviceable) to base B. Shipping after the repair improves performance over the no lateral and lateral for MICAP only (today's policy) but is slightly less effective than laterally shipping before the repair. The important point is that effective lateral resupply of assets seems to be more influential than changing depot repair policy.

The analysis indicates there is a potential to increase the Air Force's aircraft availability by redistributing assets from bases with excess AWP to bases with a higher need. Additionally, there is an added benefit from increasing the repair priority for SRUs at the base where the asset was shipped. This priority increase will provide more efficient repairs (depots repair the SRUs rather than the LRUs) and eventually provide more serviceable LRUs to the bases. The question now becomes, how should business rules be developed to determine when and where to ship from (the donor base) and where to ship to (the recipient base)?

In developing the business rules, a conservative approach was taken. Items should be laterally shipped from a base with excess assets (although we exclude excess *serviceable* assets since the Air Force redistribution system will redistribute those assets) to a base with more need, thereby reducing worldwide-

	Frequency of Lateral Supply Actions →			
	No laterals	Laterals for MICAPs	Lateral for 0 balance	Repair lateral for 0 balance
Aircraft Availability	65.0%	73.0%	78.7%	78.6%

Table 1. Lateral Supply Actions

expected back orders (EBO). Shipping from the base with excesses will increase the priority of the SRU repair. However, only assets that will decrease EBOs by enough to justify the shipping cost and not *overly penalize* the donor base should be shipped. That is, redistributing the asset would increase the SRU priority enough to give the donor base a reasonable chance to get an SRU to generate a serviceable LRU, thereby replacing the asset that the base shipped.

The business rule developed identified about 150 units for potential redistribution. The potential candidate items were limited to EXPRESS-managed LRUs and SRUs, since the goal is to increase SRU priorities in EXPRESS. The rule is as follows:

> Redistribute serviceable items from a base with excess (total) assets where it will reduce EBOs by at least .01. Limit donor bases to only those bases that have more than *50 percent of serviceable assets* on hand compared to their RO. Do not ship to a base with on-hand assets (not counting nonshipped due-ins) at or above its RO. Include all available units (DIFM assets) in the EBO calculation.

Table 2 provides some real life examples of this business rule.

For the first item listed in Table 2, the business rule suggested a serviceable item be redistributed from the donor base with an RO of five, four serviceables on hand, and seven other (DIFM including AWP) to the receiving base with an RO of six and no assets available. Redistributing this asset reduces worldwide EBOs by .77.

Out of a total of about 300 items, 152 items were identified to redistribute where both the LRU and the SRU were managed by EXPRESS, and there was a base excess. The remaining items (about 2,000) fell out because they were not EXPRESS-managed LRUs that had EXPRESS-managed SRUs causing the AWP. Redistributing the assets not only increases the SRU repair priority but also reduces worldwide EBOs. Without the redistribution, there is little or no chance the donor base will receive an SRU with the current system.

Donor Base		Receiving Base			EBO	
RO	Serv	Other	RO	Serv	Other	Change
5	4	7	6	0	0	.77
7	9	2	7	3	0	.42
7	8	2	7	3	0	.22
51	40	22	5	1	0	.17

Table 2. Total EBO Change Examples

It has been suggested that reparable AWP LRUs be redistributed to the receiving base rather than the serviceable assets. This would achieve the highest SRU repair priority because the donor bases (with the business rule) are always going to have a better support posture (more assets against its RO) than the receiving base. However, redistributing the reparable item will delay the item being serviceable at the receiving base, thereby achieving slightly less EBO reduction. Additionally, the donor base will lose its chance to get operations and maintenance (O&M) credit since it will not repair the item. As one might imagine, the donor base has little incentive to ship the reparable. Finally, as a business policy, shipping the reparable will be harder to implement. Not all bases will have the capability to repair the LRU, so EXPRESS (or whatever system identifies donor and receiving bases) will have to know base repair capabilities for each item for each base.

Clearly, the business rule, as proposed, is preferable to redistributing serviceable assets. However, there may be some benefit in changing EXPRESS to assign the SRU repair priorities (for repair at base A) to the need at base B. That is, the SRU would have the repair priority of the LRU at the donor base. As a result, the business rule could be changed to include the following.

> The SRU be prioritized using the recipient base's LRU priority.

During the major command (MAJCOM) review of the list of items to be redistributed under the proposed business rule, ACC questioned why there were so relatively few items (152) identified for redistribution. This is so because the analysis limited the list to cases where EXPRESS managed both the LRU and the SRU. If all AWP cases were included (non-EXPRESS managed items as well), the number would be 3,148. Air Mobility Command (AMC) suggested limiting the redistribution in order to preclude redistributing a serviceable asset from the readiness spares package.

Changing the business rule to limit donor bases to bases that have more than 50 percent of serviceable assets on hand compared to their RO and to redistribute only non-RSP serviceable assets would reduce the 3,148 items available for redistribution by 730. The AMC proposed addition makes the business rule more conservative, although it lessens the impact of back-order reduction.

The AFSEB agreed to have ACC test the proposed business rule and actually redistribute serviceable items with excess AWP to bases with a higher need.

Worldwide EXCESS AWP LRUs

The last remaining item is base AWP LRUs that are excess to both base and worldwide needs. There were approximately 1,600 national stock numbers and 7,560 worldwide excess AWP LRU occurrences (as of August 1999). The exchange price that would be credited to the bases upon repair and turn in of these items is approximately $42M. The average amount of base excess for these items was nearly 2, but one case had 106 AWPs over the RO. EXPRESS cannot differentiate an AWP LRU from any other DIFM detail. As part of the analysis, ACC validated the list of excess DIFM and reported more than 85 percent of DIFM were AWP.

Again, nearly half of the AWPs at the bases are excess to worldwide (base-level) needs. Unfortunately, without change, the situation will not get better; it will only get worse. Bases are collecting and holding LRU carcasses and will never get the SRUs to repair them since the Air Force will not expend resources (and grant Materiel Support Division credit) to fix unneeded assets.

NIIN	RO	OH/Due-in	DIFM	New DDR	Days of Supply	Pipeline Time	Days of Supply Pipeline Time
013565562	3	27	30	.0866	381	3.05	125
013580038	8	3	157	.3965	403	3.00	134
012947958	12	20	4	.0101	1,584	3.00	528
014114854	51	40	22	.4101	151	6.24	24

Table 3. Worldwide Excess

The AFSEB asked the Air Force Logistics Management Agency to develop a business rule and procedures to direct the bases to return (not reparable this station—NRTS) worldwide excess AWP. Again, a conservative approach has been taken—the Air Force should only NRTS worldwide excess items that have little or no chance of being needed at the base that ships the item. The goal was to develop a business rule that did not just identify excess but *really* excess items. As a result, the proposed business rule projected current needs as well as needs forecasted 2 years into the future. When projecting needs, DIFM items were also considered as demands, because demands are not recorded until asset turn-in. The rule should not direct a turn in and *NRTS* an item that would increase the demand rate and perhaps increase the RO. In essence, the rule should not force a shipment for an item that could have been within the new RO after the turn in and demand was recorded.

The rule is: *NRTS* worldwide excess from the base with the most excess if (and until) the existing assets were ten times more than the expected pipeline.

During the analysis, 10, 20, and 50 times the expected pipeline were tested. The expected pipeline is the expected demand during the repair and replenishment time. Table 3 provides four examples of items meeting the business rule.

The first item in Table 3 has an RO of 3 with 27 on hand or due in, plus 30 in DIFM (AWP). To determine the days of supply, the RO is added to the quantity of excess DIFM and then divided by the daily demand rate (DDR). In this case, DIFM assets are considered demands. For the first item, the days of supply equal 381 ((3+30)/.0866). A very conservative approach was taken, and all of the 27 assets on hand were not counted; we only count up to the RO. To get the multiple of the pipeline (the last column), days of supply are divided by the pipeline time. For the first item in Table 3, existing assets are 125 times the pipeline (381/3.05). However, for the last item, there are only 11 DIFM assets excess. Days of supply are calculated by adding the RO and excess DIFM and then dividing by the new DDR (51 + 11)/.4101). The result equals 151, and the multiple of the pipeline is 24.

Of the 1,523 units ($19.7M exchange cost) that are excess worldwide (total of EXPRESS managed items), the business rule identified 1,043 ($11.5M) units when using 10 times the pipeline, 668 ($7.4M) with 20 times the pipeline, and 222 ($.6M) if 50 times the pipeline is used. The items that the rule proposes be *NRTS* have little or no chance of ever being needed at that base.

A salient question regarding the rule is, why should the Air Force return these reparables to the depot rather than leave the items at the base? Since the depot will merely store these assets, why spend dollars to ship the items? These are DIFM (AWP) items, so they are in a maintenance repair shop. Neither base maintenance nor the Standard Base Supply System is well suited for storing and managing reparable parts. In addition, returning these items provides three other significant benefits. First, it prevents the base from repairing these items (should it obtain the necessary component parts) and spending stock fund dollars unwisely. Second, turning the items in will record demand data, thereby improving Air Force stock level and retention requirements. Finally, if the Air Force should ever need these items in the future, there is a better potential for centralized cross cannibalization of parts. Additionally, if the item contains components that could be used to make other needed items serviceable, it provides immediate cross-cannibalization opportunities.

There is no real impact on base O&M funds from turning in these reparable items. Today, the O&M in AWP is carried as *float*, and the money is not available to the maintenance organization. Since they probably will not be repaired, there will be no credit to maintenance. Turning the items in will merely *clear the float*.

Returning worldwide excess AWP end items will result in the depot returning carcasses with *holes* (SRUs missing). The Air Force Stockage Policy Work Group recommended that the Air Force identify these LRUs by directing the bases to return the items to the depot in condition code G (AWP) status rather than condition code F (unserviceable).

Implementation Actions

The AFSEB agreed with the concept of two business rules and asked ACC to test the rules. As part of this effort, AFLMA provided all the MAJCOMs two lists: one for the redistributable items and one for the items to *NRTS* to the depot. As part of the test, ACC will actually direct some redistribution and NRTS actions. The test is currently underway.

However, the AFSEB was reluctant to implement a manual process and wanted the system (to report AWP conditions, determine the items to redistribute and NRTS, and direct those actions) to be automated. This will reduce the manual workload, and automating the AWP reporting system will make the data used by the business rules cleaner.

To automate the process, the Air Force needs to implement an AWP reporting system (or reinstitute the old XE7 and XE8 AWP reporting system). The reporting system will report AWP occurrences and link the SRUs (and consumable component parts) to the specific LRU AWP occurrence. It will ensure the SRU gets the correct repair and distribution priority and will provide a means to update, check, and correct the AFMC indenture file. It will also automate the redistribution and directed NRTS actions. Specifically, the centralized reply to the AWP report will direct a shipment when appropriate.

The business rules must be included as part of the D035 Stock Control System and/or EXPRESS to identify what items are to be shipped. Once directed, the AWP reporting system will execute the shipment (send the shipment transactions).

During MAJCOM review of the items identified for redistribution and retrograde, AMC found that some items were incorrectly identified as excess at centralized repair activities (CRA). A CRA can and will have excess AWP and DIFMs, since the CRA is repairing for other supported bases. The proposed business rules must consider CRA activities; implementation of the business rules should provide a method to exclude selected (CRA) bases from being designated as donor bases for redistribution actions. Then the worldwide excess rule should be set at a higher level, perhaps 50 or 100, for CRA activities.

The implementation of the AWP proposals should be managed as part of the Seamless Supply IPT 1, Air Force-Managed Items, initiatives. The implementation actions require close coordination between the wholesale and retail systems. Note the long-term goal of seamless supply is to make centralized repair decisions regardless of where the repair takes place. So a central supply system would make the determination and prioritization of a base repair decision at the time the part was pulled for the weapon system.

Summary and Recommendations

Summary

The Air Force has more than 15,000 AWP end items at the bases, and for 63 percent of the items (base and worldwide excess items), there is little or no chance to reduce the number of AWPs with the current system.

EXPRESS will not prioritize repair of component SRUs at a level to repair AWP LRUs that are excess to a base's need even if there is a need at another base (15 percent of the AWP conditions).

EXPRESS will (correctly) not give a high priority to the repair of component SRUs to repair worldwide excess AWP LRUs (48 percent of the AWP conditions).

EXPRESS 3.1 implemented the AFSEB-approved proposal to prioritize the SRU with the LRU priority for all AWP LRU conditions, including Spares Priority Release Sequence (formally BOA Release Sequence) category items.

Implementing the proposed business rule to redistribute serviceable items from bases with excess AWP to bases with a greater need will:

- Increase the Air Force's aircraft availability,
- Reduce expected back orders, and
- Increase the repair priority of SRUs, thereby reducing the number of AWP conditions.

Implementing the business rule proposal to NRTS worldwide excess AWP LRUs will:

- Prevent the base from inefficiently using stock fund dollars to repair unneeded items,
- Allow for accurate recording of failures and improved retention and requirements computations, and
- Significantly reduce the number of AWP items at the base.

Implementing an AWP reporting system will:

- Link the SRU to the specific LRU AWP occurrence,
- Ensure the SRU gets the correct repair and distribution priority,
- Provide a means to update and correct AFMC's indenture file automatically, and
- Implement the proposed business rules to redistribute and direct NRTS actions.

Implementing the AWP proposals will:

- Increase Air Force-mission support by reducing back orders and increasing aircraft availability,
- Make better use of stock fund dollars,
- Reduce base AWP,
- Increase SRU repairs (using the right priority), and
- Automate the base and worldwide excess business rules.

Recommendations

- Implement the business rule to redistribute serviceable items from bases with excess AWP assets to bases where it will reduce worldwide EBOs.
- Implement the business rule to direct return of worldwide excess items.
- Implement the proposed AWP reporting system.

Notes

1. AFSEB was formed to discuss long-range requirements of the Air Force supply system and formulate or approve proposed strategies for achieving these long-range goals
2. EXPRESS is a software program designed to prioritize both repair and distribution of reparables based on flying hours and mission-tailored priorities.

There is a golden rule: just in time, not just in case. He who breaks this rule loses his gold.

—Group Captain David J. Foster, RAF

Logisticians are subject to the effects of friction and uncertainty almost every day and, yet, often forget their effects when planning—or conversely, try to anticipate and plan around every possible contingency

—Colonel Karen S. Wilhelm, USAF

The only thing harder than getting a new idea into a military mind is getting an old one out.

—B. H. Liddell Hart

Logistics Quotes of Note

Surely one of the strangest things in military history is the almost complete silence upon the problem of supply.

—Shaw

During the last war 80 percent of our problems were of a logistical nature.

—Field Marshal Bernard Montgomery

There is no one but yourself to keep the back door open. You can live without food, but you cannot last long without ammunition.

—Lieutenant General Walton Walker, USA

The history of war proves that nine out of ten times an army has been destroyed because its supply lines have been cut off.

—General Douglas MacArthur, USA

The desert—a tactician's paradise, a quartermaster's nightmare.

—Attributed to a German general

The supreme excellence is not to win a hundred victories. The supreme excellence is to subdue the armies of your enemies without having to fight them.

—Sun Tzu

I don't ever, ever, ever want to hear the term logistics tail again. If our aircraft, missiles, and weapons are the teeth of our military might, the logistics is the muscle, tendon, and sinew that make the teeth bite down hard and hold on—logistics is the jawbone! Hear that? The JAWBONE!

—Lieutenant General Leo Marquez, USAF

When it comes down to the wire and the enemy is upon you and you reach into your holster, pull out the pistol, and level it at your adversary, the difference between a click and a bang is logistics.

—Editors of *Loglines*

If the old adage that war is too important to be left to the generals holds a nugget of truth, it is also true that military privatization is too important to be left to civilian accountants.

—Colonel R. Philip Deavel, USAF

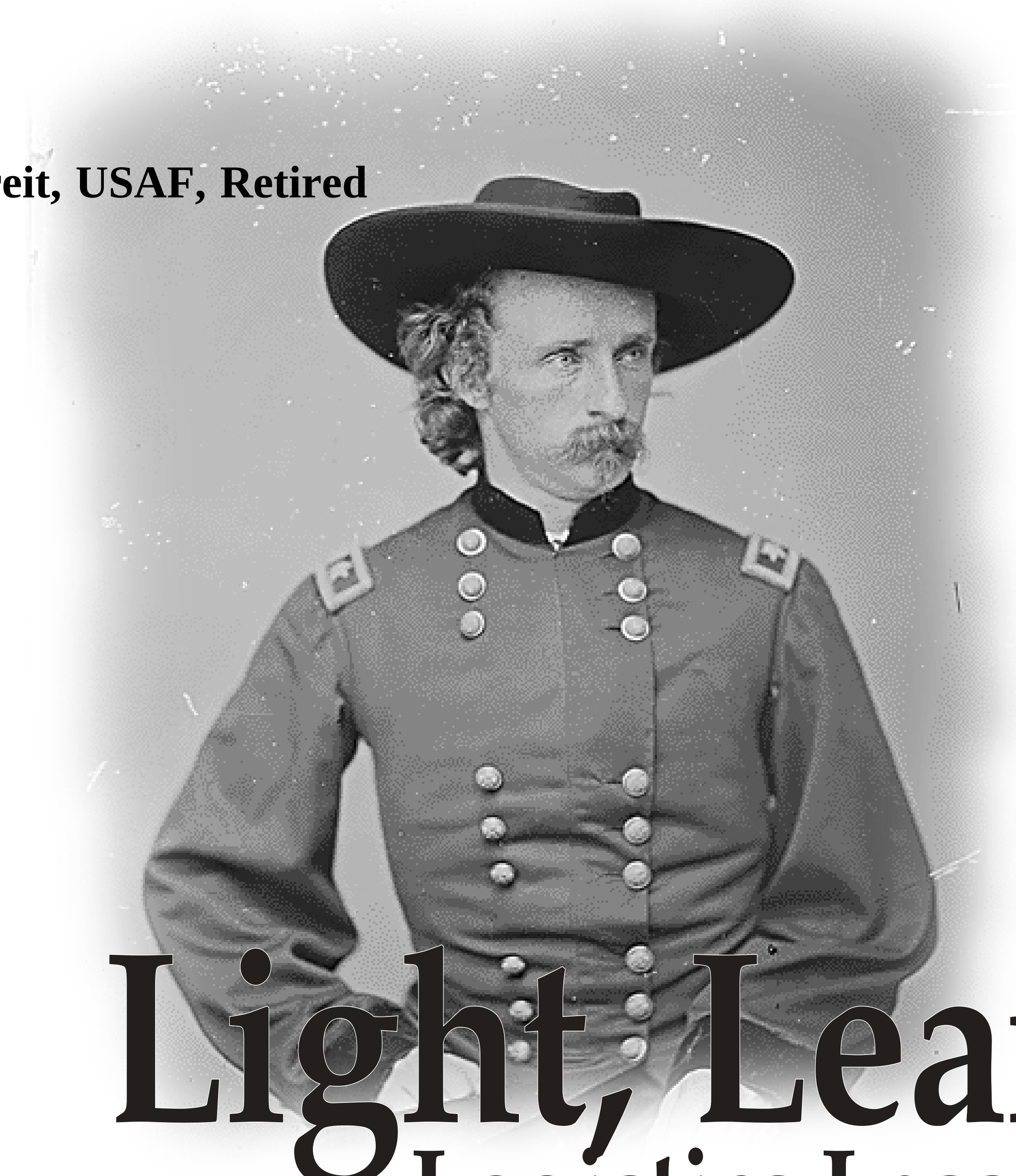
The inevitable never happens. It is the unexpected always.

—John Maynard Keynes

Vulnerability lies in the equipment chain, from manufacturing to employment, and other similarly interdependent systems such as fuel and pilot training . . . logistics might well be considered the real center of gravity.

—Air Commodore Peter Dye, RAF

Colonel Richard M. Bereit, USAF, Retired



Light, Lean, Logistics Lessons

In this country . . . no man need fail in life if determined to succeed . . . .”

—Major General George A. Custer

On 25 June 1876, 211 Americans (soldiers, scouts, journalists, and contractors) were struck down near the Little Bighorn River. Every soldier under Lieutenant Colonel Custer’s (Brevet Major General George Armstrong) direct command was killed, a rare occurrence in US military history. What went wrong? What impact did logistics have on shaping the battlefield and forces? And most important, what are the lessons that would prevent American forces from suffering such a defeat again?

and Lethal
from the Little Bighorn

A Young but Proven Leader

Custer's own credentials were impeccable. He was a West Point graduate, a superb cavalry officer, and the youngest soldier to be made a brevet brigadier general in the history of the US military.[1] When promoted to brevet major general, he was the youngest American to ever hold that rank.[2] Military historians rank Custer below only General Philip H. Sheridan and Major General Alfred Pleasonton as an American cavalry tactician and field commander.[3] Custer was schooled and experienced, and he understood the importance of logistics. He was also notorious for his willingness to attack a larger force.[4] On the last and most critical day of the Gettysburg campaign, Major General George G. Meade's army stopped Major General George E. Pickett's charge at the center-front of the line. It was Custer's (age 23 and recently promoted to brevet brigadier general) Michigan Cavalry that repulsed the cavalry attack by Major General J. E. B. Stuart's Invincibles at the Union rear.[5] In the final days of the war, Custer's cavalry rushed to Appomattox Station to capture four Confederate supply trains, which Lee desperately needed. Cut off from both his supplies and his means of escape, Lee surrendered.[6]

Pursuing an Elusive Enemy

As Custer headed up the Rosebud River on 22 June 1876, his soldiers and packtrain carried supplies for a 15-day march. His orders were to march to the headwaters of the Rosebud, looking for the main Sioux camp. Each man carried 100 rounds of ammunition for his carbine and 24 rounds for his pistol.[7] Brigadier General Alfred H. Terry's (Major General) and Colonel John Gibbon's (Brigadier General) forces were to travel aboard the riverboat *Far West* up the Yellowstone and Bighorn Rivers, as far as water depth would allow. The combined forces of Gibbon and Terry, moving by river from the north, were to link up with Custer's force, coming overland from the south, thus trapping the Sioux between them.[8]

Based on Custer's own estimate of distance and speed of 25-30 miles per day, the rendezvous was to be made on 26 June. However, on the 24th, Custer increased the normal rate of march to 40 miles by traveling most of the night and early morning.[9] Consequently, he reached the headwaters of the Rosebud at around 3:15 a.m. on the 25th. This accelerated pace left horse and soldier tired and hungry. After only a short rest, he continued another *12 miles that same day.*[10] Custer's scouts had sighted campfires from a very large Indian village, approximately 14 miles to the north on the west bank of the Little Bighorn River. He knew he was closing in on his prey but was not convinced this was the main village.[11]

At this point, he divided his force into four components. Three troops (125 men) under Captain Frederick W. Benteen (Brevet Brigadier General) were sent northwest at a 45 degree angle to scout for Indians to the west of the Little Bighorn River and provide defense on the left flank. Major Marcus A. Reno (Brevet Brigadier General) with three troops (140 men) was sent up the center to attack the village from the south.[12] Seven soldiers from each of the other 11 troops were detailed to Captain Thomas M. McDougall (Brevet Brigadier General) to guard the packtrain and baggage. These 130 men were more than 20 percent of the total regiment.[13] Custer took five troops (225 men and most of the scouts) with him. He ordered an increased rate of march, leaving his packtrain well behind the attacking force.[14]

The Battle Begins

The battle occurred in three phases and at three separate locations.

Reno, up the Middle. The first to engage the combined Sioux and Cheyenne forces was Reno and his 140 troopers and scouts. He forded the Little Bighorn south of the village and advanced along the west bank to the edge of the encampment. He had been assured the rest of the force would support his attack. As he advanced, he was met by increasing numbers of mounted and running warriors to his front and left flank. The combined force of Sioux and Cheyenne warriors was much larger than he had expected. Post-battle estimates of warrior strength were 3,000-5,000. The highest prebattle estimate had been 1,000-1500, though Custer's own Indian scouts believed the number was much higher.[15] Reno halted the advance and took up a defensive circle in a large clump of trees near the river. Measurement of the village after the battle revealed a camp 4 miles long and a half mile wide. Reno could see that his brigade was being encircled. Indian warriors were also running along the bank across the river. Neither Benteen's nor Custer's force had come to his assistance. After 30 minutes of fighting in the trees, Reno ordered his men across the river to a more defensible position. Not all his men heard the order, and several were left in the trees. He withdrew most of his force and established a defensive position among the high bluffs on the opposite side of the river.[16]

Benteen, to the Left. During the same time, Benteen's brigade searched the plain to the west and found neither trail nor Indian. By the time he returned to the Little Bighorn, Reno's force had recrossed the river. Benteen joined forces with Reno and led the effort to build defensive positions along the high bluffs. From those positions, the combined brigades fought the evening of the 25th and all day the 26th against continuous attacks. They, too, would likely have been entirely wiped out had Terry's force not arrived the morning of the 27th.[17]

Custer, to the Right. Custer, with his five troops, proceeded downstream on the east side of the Little Bighorn valley. (Since there were no survivors, his final moves and intentions can only be surmised. However, subsequent interviews with Sioux and Cheyenne warriors, as well as studies of spent bullets and body locations, have added some understanding.) Custer attempted either an actual or a feint crossing at a point directly across the river from the center of the village. He withdrew and again headed north, perhaps to find a point of attack at the north end of the village[18]

Captured chiefs who participated in the Battle of the Little Bighorn, circa 1877

He must have been surprised at the size of the village and the number of warriors that rushed to meet him. His troops dismounted on a sloping field, cut by numerous ravines, unsuitable for mounted maneuver. They formed several defensive circles. Early in the battle, the advancing Sioux stampeded their horses. This deprived them not only of a way to escape but also of the spare ammunition. Armed with only pistols and carbines and the ammunition each soldier carried, they succumbed to a force at least ten times their number.[19] Thus, the entire force was pinned down, encircled, and killed.

Was it Just Bad Leadership?

Most historical analysts have focused on Custer's, Reno's, and Benteen's actions and leadership. Historians have alternately criticized the decisions of all three. It was well known that Benteen and Reno (who survived) had been critics of Custer. It should be remembered, however, that all three of these men were decorated Civil War veterans, and all had been commended for acts of courage. There were other factors that weakened the force. For instance, communication between the widely dispersed units was nonexistent.[20]

> Mounted couriers were the fastest means available but were still slow and uncertain. Soldiers could be used as couriers only when the route was both familiar and safe; otherwise, this duty demanded skilled frontiersmen. The slowness, however, meant supplies had to be arranged far in advance and could not be adjusted as needed. Another consequence was that concerted action between far-separated columns was nearly impossible.[21]

No specific battle plan had been communicated before the three elements divided, and no one expected several thousand Indian warriors to be present. No one, not even the Indian scouts, had ever even seen a Sioux/Cheyenne encampment of more than 600-800 warriors. Most analysts, whether Custer fans or critics, agree that the principal cause of the defeat was Custer's dividing of his force in the face of an enemy of unknown size, allowing the much larger Indian force to fight his units one at a time.[22] The Army commission that examined the events found no fault on the part of Reno or Benteen.[23] Since there were no eyewitnesses to the last 2 hours of Custer's actions and because of his fame as an Indian fighter, the board was equally reticent to place blame on him. The board's conclusion was Custer attacked a force of unknown size, which turned out to be larger than predicted. Dividing his force into three separate elements (a tactic that had *worked well* for him on multiple occasions in both the Civil War and previous Indian campaigns) further diminished his capability. Finally, by attacking alone on the 25th, he eliminated an opportunity for a combined attack with Terry and Gibbon.[24] So is that it? A few bad choices based on poor intelligence? Were there other factors that affected the outcome?

Changing Times, Changing Force

Custer lived during a period of postwar transition, similar in many ways to our own post-Cold War and Desert Storm era. While Custer had perfected his tactics in one kind of war, in 1876, he was leading an expeditionary force in an entirely different kind of war. To make matters worse, the Army had made no attempt to develop doctrine and strategy for the Indian campaigns.

> The Army brought to the task no new strategy. In fact, there had never been any formal strategy for fighting Indians, and there never would be. The generals looked on Indian warfare as a momentary distraction from their principal concern—preparing for the next foreign war.[25]

In this war with the Indians, the *cavalry* had become the *primary* attack force, supported when and where possible by artillery and infantry. From 1863 to 1865, Custer had led a group of volunteers who were committed to winning the war. The men submitted willingly to capable leadership. They knew each battle hastened the war's end and their return home. When the war ended, most of them did. The composition of the force after the war changed markedly. The cavalry units in the Far West were mostly manned with recruits from immigrant families.[26] Units often had as many as 40 percent trainees. The Civil War was *popular* and had a clear, expected end, but duty in the west was not so well defined. It was endless drudgery, units had high rates of desertion,[27] and soldiers who remained were often incapacitated by alcohol.[28] Actual combat experience was rare. It is estimated that as high as 30 percent of the men who rode with Custer never had been in combat prior to the Little Bighorn.[29]

A Different Kind of Enemy, A New Kind of Warfare

As Custer pursued the Sioux across Wyoming and Montana in 1876, he was attempting to find and fight an entirely different kind of enemy, in surroundings much different than Gettysburg and the Shenandoah Valley. The Army rarely was able to locate and fight Indians in large numbers, and the Indians did not engage in frontal, force-on-force battles. They chose opportunities where they momentarily had superiority and surprise. Their warfare consisted of guerrilla tactics, and when engaged by a larger force, they would disperse and *disappear* in the vast plains. Only a mobile force was going to be able to catch this elusive enemy—a force that was light and fast.

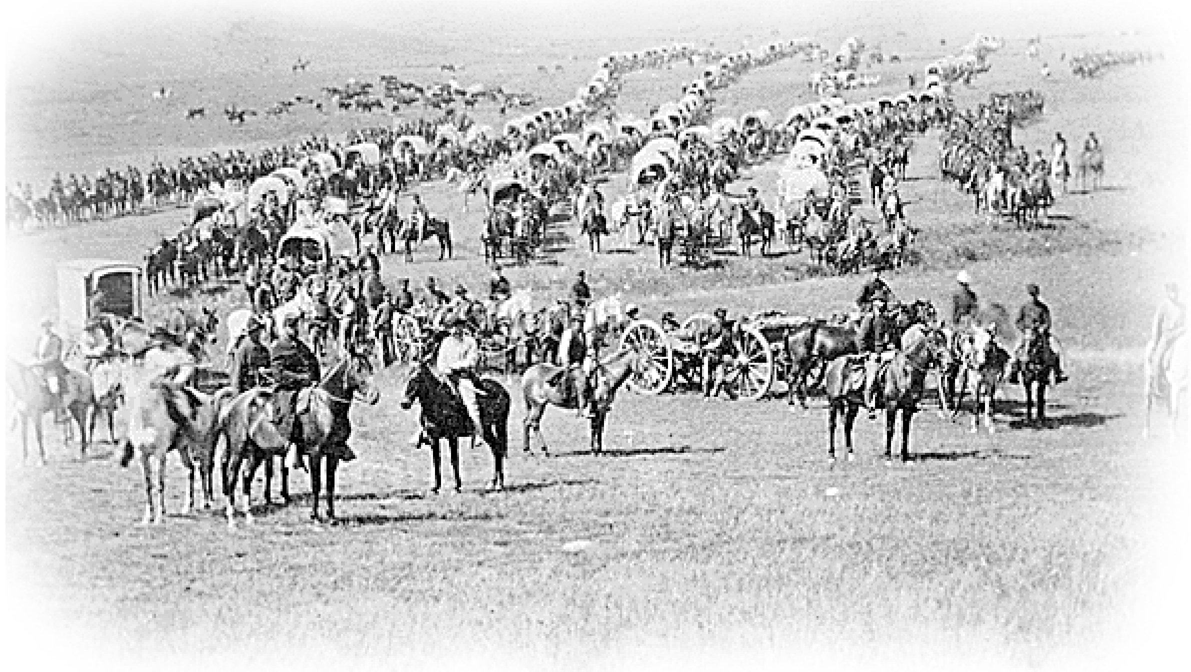
What About Logistics?

There were *significant* logistics decisions that contributed to the outcome. Perhaps the best known was Custer's refusal of the Gatling guns and additional forces offered by Terry. Custer reasoned that dragging the guns and ammunition over mountain trails would have decreased his speed and ruined his chances of finding the elusive Sioux.[30] A lesser known decision was Custer's order to box all the sabers and leave them aboard the supply ship, the *Far West*. Custer felt they would make too much noise and there was little chance of close-in combat.[31] In the final hours of pursuit, Custer increased the rate of march, leaving his baggage train and reserve ammunition far to the rear. There are several other lessons from the Little Bighorn that offer valuable insight for modern expeditionary force planners and warriors.

Expeditionary Logistics

Logistics support in the Far West was extremely difficult. Supporting concentrations of men and horses in the field was always a huge task, but in the desolate Far West, it was nearly impossible to keep every man and horse supplied all the time. The difficulty of moving, storing, and calling forward military supplies reduced the effectiveness of forces and reduced the scope of the possible. Field commanders were tethered to and limited by a very rudimentary logistics infrastructure. John S. Gray's analysis of frontier logistics is extremely insightful and thought-provoking:

> These preliminaries to the Sioux campaign of 1876 provide a glimpse into the difficulties the frontier army faced in conducting a major campaign against the plains Indians in the formidable wilderness of the West. The problems stemmed not from army incompetence, but from the unusual conditions, especially alien to a force trained in the Civil War in the developed East. For the benefit of today's readers, these monumental problems deserve an explanatory note.
>
> The West posed special problems in logistics—the transport of troops and their essential supplies. Veritable mountains of rations, shelter, clothing, arms, and ammunition for the men, and forage for the animals had to be delivered over long distances. Facilities for such transport were readily available in the densely populated East but not in the forbidding, unsettled, and arid West. There, steamboats could ply only a rare river and then only in spring and summer. The Union Pacific was the only railroad west of the Missouri, and winter service was erratic indeed. Even wagon roads were few and rough, which translates to long and slow. Army contract trains, usually ox-drawn, made only 15 miles a day to allow grazing time, for to carry forage meant no payload. Quartermaster trains that supplied immediate needs of troops on the march were usually mule-drawn and could make 20 miles a day. As we have seen, even the assembling of troops and supplies at a staging base was time-consuming and often impossible in winter.
>
> After the staging base was left, transport problems intensified, for there were often no roads whatever. Yet, a trail suitable for heavily laden wagons simply had to be found, with essential wood, water and grass at each night's bivouac. In unfamiliar country these requirements called for expert guides. For any prolonged operation, supply depots had to be established in the field and then replenished by successive supply trains; troops, usually infantry, had to be detached to guard such depots.
>
> The cavalry was the most mobile, but its range was inversely proportional to its speed. The range could be extended and speed still maintained if the column was supplied by a packtrain, but only Gen. Crook [Major General] had developed an efficient one that could keep



Logistics supply for Custer's forces. Note the use of mules—fast transportation circa 1870s.

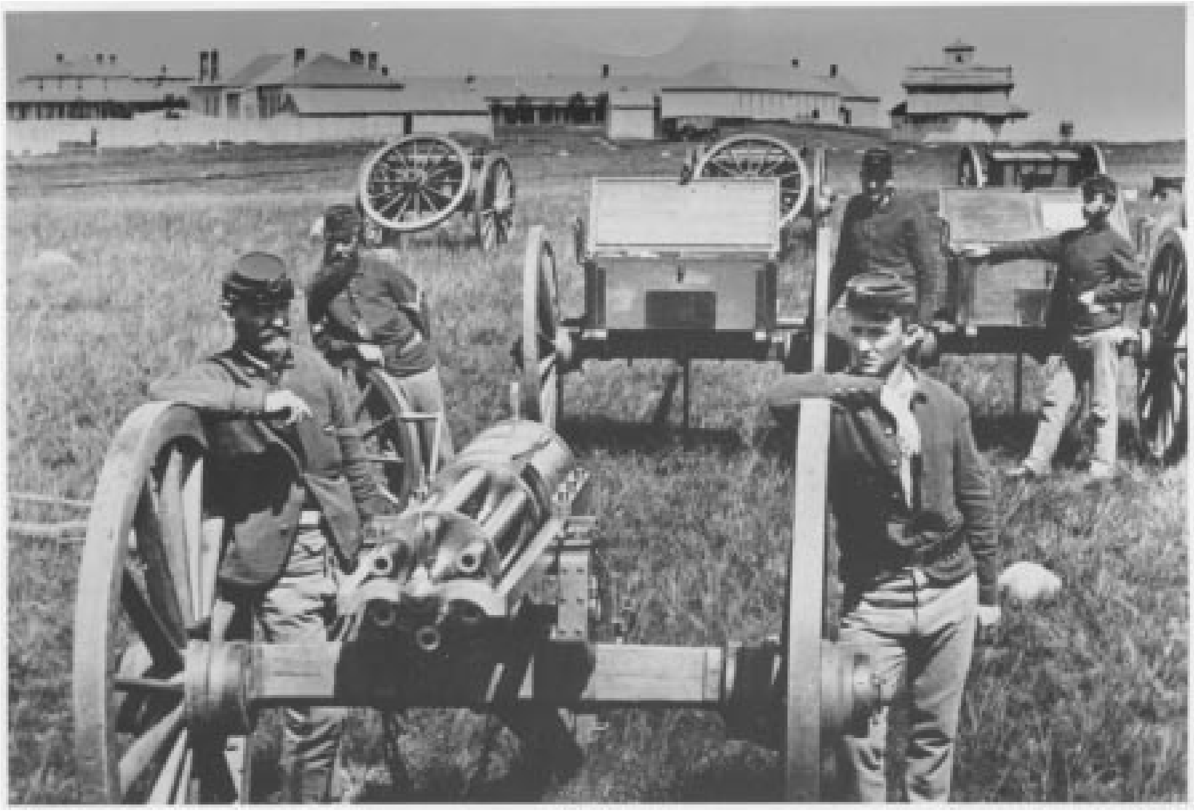
> up with the cavalry it served. It consisted of specially trained mules managed entirely by *expert civilian packers* and therefore *too expensive for general use*. Others had to rely on draft mules and novice soldier-packers that both slowed and weakened the cavalry column.[32]

Sheridan had ordered a winter campaign in 1875. He knew that was when the Indians were at their weakest. Indian ponies were undernourished and generally ineffective during the winter months. Villages were scattered, and a number of warriors were always away from the village hunting for food. He failed to reckon with the logistical problems of mounting forces in isolated, winter-bound posts.[33] During the winter, natural fodder was not available in sufficient quantities to support a large equestrian force. Sheridan and Custer had conducted smaller winter campaigns previously. The Washita Campaign (winter 1868) had used *400 wagons* to support the combined cavalry and infantry force.[34] However, a three-division force simply could not be supported in a winter campaign. After months of delay, when the spring of 1876 arrived, the steamboat *Far West* was loaded near Fort Lincoln, at Bismarck, and began to move Terry's supplies up the Missouri and Yellowstone Rivers. The troops and horses moved overland from Bismarck, west to the Yellowstone River, where they would link up with their resupply ship. The overland contingent was well stocked for the march—150 wagons drawn by 6-mule teams, an equal number of 2-mule wagons, a towed battery of Gatling guns, a herd of cattle, and a herd of extra horses and mules. The whole group, soldiers, and supplies, stretched over *4 miles*. The *Far West* was also well stocked, including a battery of Gatling guns and 10,000 rounds of half-inch ammunition, as well as large stocks of food and medical supplies.[35]

Logistics Decisions

Custer sized and equipped his force by evaluating his own capability compared to probable enemy capability and intent. Custer's decision to leave Gatling guns, sabers, and his own spare ammunition in the rear left little flexibility to adjust to changing conditions and new intelligence. Once engaged, both Custer and Reno sent couriers to the packtrain, requesting it make every effort to catch up.[36] Eventually the pack mules, which carried ammunition, were detached from the rest of the baggage train to speed their progress. In his careful time-motion analysis, Gray determined that the mules with ammunition arrived at the Benteen/Reno position on the bluffs at 5:19 p.m. The rest of the baggage arrived at its location 10 minutes later. The Reno/Benteen position *was 4.5 miles* from Custer's battlefield, easily another 30 minutes away. By 5:12 p.m. (7 minutes *before* the ammunition arrived at the bluffs), heavy firing had ceased at Custer's location.[37]

While the newly arrived baggage was of great use to Benteen's and Reno's forces during their battle over the next 24 hours, it was clearly too late to support Custer. A clear pattern emerges. Custer continually lightened his force in order to achieve maximum speed. These decisions were based on his estimate of enemy numbers and intentions. By the time he realized these estimates were wrong, his force had been trimmed too much to respond to the changes. Even his own (relatively close) supplies were unavailable when he needed them because of his decision to close the distance with the enemy quickly. Being light and fast enough to keep pace with the Indian was only possible by becoming *like* the Indian, especially as it pertained to logistics. A traditional cavalry unit could not expect to remain in contact with its forward supply depots *and* keep up with the mobile Indian. Therefore, tradeoffs were made, capabilities



Gatling gun and crew circa 1876. Custer's decision to leave the Gatling guns on the *Far West* contributed to his defeat at the Little Bighorn.

jettisoned, and some useful weapons left behind. At the moment of battle, however, the attacking force lacked the resources to win; all the benefits of speed achieved through being light were lost. Custer had caught up with the elusive Sioux but lacked the capability to deliver a lethal blow to his adversary or to defend his own force.

Issues for Today

The Services are shaping forces designed for rapid mobility and quick response—forces that can deploy rapidly and fight anywhere. To do this, there is a move toward lighter/faster forces.[38] Though they reduce deployment time and beddown footprint, lighter forces are more vulnerable. Is it then a clear *either-or* problem? *Either* we field large, heavy, slow forces, which can win, *or* we field small, light, fast forces, which may be in jeopardy? Clearly, there is a need for both kinds of forces. However, if arrival speed and rapidity of engagement are a high priority, there are factors affecting light, mobile forces that must be considered.

Unity Among Intelligence, Operations, and Logistics

Most analysts concur that the critical failure in Custer's defeat was poor intelligence of enemy strength. Consequently, decisions to split his force and move ahead of the packtrain left him with too few soldiers and not enough firepower. Intelligence of enemy capability and intent is critical in sizing the expeditionary force. To successfully plan and execute a rapid response package, the *loggie* must be brought in at the earliest stage of planning. Support not only must be tailored to the requirements of the warfighter but also must factor in enemy strength and intent. Intelligence is rarely 100 percent accurate. Many items of information needed to make operational decisions are not always available. In the absence of critical information, we need to build capacity into logistics that accommodates changing estimates of enemy capability. Logistics planning needs to include estimates of enemy capability to interdict supply and should calculate likely attrition. The intelligence, warfighter, and logistics commands need to constantly coordinate new information. If a decision is made to delete a weapon system or limit units to only a few days of supplies on hand, all three communities need to consider the implications.

"Call in the cavalry . . . "

In the West, the cavalry's mobility made it the force of choice. It could move quickly to a *hot spot*. However, there were instances when the cavalry was dispatched with disastrous results. Custer's defeat at the Little Bighorn is the best known, but there had been others. Only days before Custer's loss, Crook's cavalry was mauled near the Rosebud River.[39] Though Custer is credited with a victory at Washita, Major Elliot, his second in command, and a dozen troopers were surrounded and annihilated during that same battle.[40] There are circumstances that demand a mobile force. However, a light force may not always be the best solution. In some scenarios, we will need to take the time for *heavy* units to deploy. While Terry planned to use the cavalry to chase and pin down the enemy, he also planned to use infantry and artillery. He understood that the cavalry could be defeated if not properly supported.

Choosing Time, Place, and Pace (or, the closer you get to the enemy, *the closer he is to you*!)

Building an airbase has historically been a very slow process. Doctrine and strategy, force size, and national objectives have been sifted annually. Basing decisions flowed from strategic policy. Generally, airbases were sited *out of harm's way*. Buildup and stockage took months, even years. Responsibility for defending the airbase has sometimes been contentious. The means and methods of airbase defense have been inconsistent during the fixed-base era. As the Air Force moves toward expeditionary air forces, it will need to decide which units will provide base defense. Selection of airbase sites will also bring new challenges. Speed and current (rather than potential) support capability may move units to places that have exceptional operational capability but shortfalls in base defense and logistics support. Bare and semibare bases will need to be selected not only for operational capability but also for defense feasibility and logistics supportability. We have grown accustomed to *NATO-like* bases with full support capability. But in parts of the world, the number of suitable bases is limited. While a light combat force may fit well at a selected location, the required base defense and engineering units may make the total package anything but light. The closer the base is to the enemy, the more urgent the defense solution.

On Hand Versus On Time

A critical component of expeditionary warfare is assured supply. The amount of stuff required *on hand* must be balanced with the amount of stuff that can be delivered *on time*. Determining how much of each will always be difficult. During Desert Storm, there were isolated incidents of the enemy's surrendering to unmanned aerial vehicles. In other conflicts, enemies have fought to the last man. The enemy's *will-to-fight* factor affects the rate of expenditure and the requirement for on-hand stuff, especially munitions. Historically, we have been unable to reliably calculate the number of bombs it takes to deter or halt an enemy. Custer believed the weapons and ammunition carried by each trooper were sufficient. After all, each man had not only the bullets he carried on his person but also reserves in saddlebags. There was enough Army firepower within a 50-mile radius of Custer's position to wreak havoc on an unlimited number of Indians. But it was not available where needed. Custer's own reserves were diminished, first, by his decision to position himself in advance of his packtrain and, subsequently, by Indians chasing off the horses. If a unit will deploy with only 3 days of supply today, for instance, what is the backup plan if the lines of supply are cut during those 3 days? With regard to critical supplies, such as munitions and fuel, what rates of expenditure are likely to achieve the goals, and are there sufficient quantities on hand for the moment and the future? Security of on-hand supplies also has a cost. Custer committed 20 percent of his force to defend his own packtrain. These men were desperately needed *warfighters*. Establishing and protecting support in an expeditionary mode will require initial planning and continual tuning as conditions change.

Weapons of Choice Plus Flexibility

As Custer chose to leave behind Gatling gun batteries and sabers, so must the modern expeditionary commander leave behind some capabilities. Selection of weaponry from a list of possibles will be difficult. The decision will need to be rooted in enemy capability and intent. It will also be affected by the availability of those weapons and their deployability. Air Force planners have rarely been faced with selection of only one or two types of weapons, fuses, and delivery options, but rapid-response forces will have fewer options. Light forces will need to be carefully shaped to maximize lethality. Decisions, like Custer's—to leave the sabers behind—need to be made after considering any potential changes in enemy strength and intent.

Quality of the Force

In the 1879 inquiry, several eyewitnesses stated that fire control was poor. Many of the men fired their weapons rapidly, often without aiming, reducing effectiveness and ammunition.[41] Custer's unit was like others in the Army at the time. There was a high percentage of recruits, and many soldiers had no combat experience.[42] The rate of ammunition consumption was related directly to the quality of the force. Parallels exist today. Many aircraft maintenance areas are undermanned. There is a shortage of experienced technicians. Experienced seven- and nine-level troubleshooter numbers have also decreased. An experienced specialist might use only one *widget* to accomplish a repair while an inexperienced one might use two or maybe even three. A less experienced/trained force will affect consumption of support and warfighting materiel. Is the 3-day package sized to well-trained technicians? It is interesting to speculate, for instance, what Custer might have accomplished at the Little Bighorn with troopers from the 7th Michigan Brigade, his Civil War unit. It is possible, that a unit with greater discipline, fire control, and battle experience might have had sufficient ammunition to repel the Indian counterattack. More experienced troopers might not have allowed their horses to be stampeded. Each factor (quality of the force, experience, operational capability, enemy intent, and so forth) is linked to the others. Under ideal conditions, with overwhelming force, weaknesses may remain hidden. The expeditionary force may surface weaknesses that did not affect large force packages.

Combining Forces—Joint and Allied

The Indian scouts attached to Custer's overland force were among the best in the Montana and Wyoming area. However, they were not Custer's own scouts. He had not worked with them before and had not established confidence in their ability.[43] As a result, he did not act on their assessment of enemy strength being much higher than 1,500. He also did not believe they had located the main Sioux village, though several of the scouts told him they had seen rising smoke and a large herd of ponies. Immediately prior to battle, these *untried* scouts were his only source of intelligence. This was not a formula for success. Expeditionary forces will deploy to places where few previous treaties and agreements exist. Possible hot spots may take them to places where military-to-military exchanges have been few and allied exercises have been infrequent. Expeditionary forces will be faced with unfamiliar terrain, bases, support, contractors, ports, infrastructure, and local sources of information. There will be language difficulties. Like Custer, the on-scene commander may have little time to build relationships with local forces and agents.

Effectiveness Versus Efficiency

The goal of modern logistics is to precisely calculate requirements by modeling past consumption and deliver the right amount of stuff to the point of use a little before it is needed. The optimum solution is to shoot the last bullet, at the last enemy, on the last day of the war. The problems in this approach arise, not from inability to construct accurate consumption models, but from difficulty blending enemy capability and action into the model, as well as other variable wartime factors. The light, mobile force seems to promise dollar savings. It is important that, while we move the military toward a higher ratio of light-to-heavy forces, the desired *efficiencies* do not undercut *effectiveness*. This is a tension that shaped Custer's force, one Americans will debate in each new generation. How much is too much? Can we ensure victory with fewer forces and dollars? Which numerical ratios and formulas best capture combat effectiveness and budgetary efficiency?

This dialog from Robert Vaughan's historical novel *Yesterday's Reveille* cleverly portrays this tension, as expressed in Custer's time.

> Congressman: "The yearly cost for keeping the Seventh Cavalry—including all pay, allowances, food, and equipment—is one million, two hundred and thirteen thousand dollars. Last year, there were two hundred and seventeen hostiles killed. That means it is costing the United States five thousand five hundred eighty-nine dollars and eighty-six cents to kill *each Indian* . . . . Now I ask you, General Custer, do you consider this an effective utilization of Federal money?"
>
> General Custer: "Mr. Congressman, if you consider the Seventh Cavalry to be nothing but bounty hunters, then I would agree that too high a bounty has been placed on the head of each Indian. If, on the other hand, you regard the Seventh as a peacekeeping organization, then I would ask you to turn your figures around. There are approximately three-quarters of a million men, women, and children in the Department of the Missouri who were not killed last year. I ask you, sir, if you consider the lives of these American citizens to be worth a dollar and sixty-three cents apiece?"[44]

Conclusion

These issues, and others, must be analyzed as we attempt to shape light, mobile forces and doctrine to accommodate political, demographic, and military realities. We would be wise to consider similar periods in our national and military history. Custer's expeditionary force was remarkably mobile and light for its day. His *lightness*, though, reduced lethality and margin for error. Our responsibility is to learn from Custer's successes and duplicate them, understand his mistakes and correct them.

Notes

1. Gregory J. W. Urwin, *Custer Victorious*, East Brunswick, New Jersey; London; and Toronto: Associated University Presses, 1983, 44.
2. W. A. Graham, *The Story of the Little Bighorn*, Mechanicsburg: Stackpole Books, 1994, 8.
3. Urwin (particularly testimony of men who served with Custer during the Civil War), Chap 12, 265-286. During the early years of the Civil War, the Union cavalry had been notoriously ineffective, poorly trained, and poorly led. However, by 1863, under the tutelage of Sheridan and Pleasonton, the Union cavalry had improved dramatically. By the end of the war, Custer's units had won numerous battles.
4. Jay Monaghan, *Custer: The Life of General George Armstrong Custer*, Boston and Toronto: Little Brown and Company, 1959, 314.
5. Urwin, 73-82.
6. Monaghan, 240-242.
7. Graham, 96.
8. Graham, 12-13 and 114-117 This letter contained the written instructions to Custer, which were recorded after the meeting aboard the *Far West*. While some latitude is granted, it is clear where each of the forces were to move.
9. John S. Gray, *Custer's Last Campaign*, Lincoln and London: University of Nebraska Press, 1991, 205 and 229.
10. Gray, 228, 251, 272, 338. These time-and-motion study charts are an extremely precise calculation of movements during the last hours of Custer's attack.
11. Gray, 238, and Graham, 29.
12. Robert M. Utley, *Cavalier in Buckskin*, Norman and London: University of Oklahoma Press, 1988, 182-183.
13. Graham, 27 and 96.
14. Utley, 183.
15. Gray, 212, 226, 244. There is great variance in numbers. Low estimates, before the march up the Rosebud, were 400-800. As signs of many trails joining increased, so did the estimates. One scout estimated as high as 2,500 on the morning of the 25th. Custer felt that, regardless of the number, the Indians would flee when they saw his column advancing and his troops could whip any number of Indians. See also, Graham, 33-34. Graham's book was researched and published the closest to the actual events. He talked to eyewitnesses, and he estimates the actual number of warriors to be 4,000.
16. Graham, 36-48.
17. Graham, 51-61.
18. Gray, 357-361.
19. Utley, 185-191.
20. Graham, 23,24.
21. Gray, 133.
22. Gray, *xiv-xv*.
23. Gray, 102-104
24. Gray, 152-158, These pages contain a copy of the final report from the 1879 court of inquiry. It delineates the actions of each primary officer and concludes each acted properly and under orders.
25. Utley, 42.

26. Utley, 45-46, 168.
27. Utley, 45-46, 50, 52, 53.
28. Utley, 45. A major shot and killed himself in a fit of delirium tremens during the 1867 summer campaign. Alcohol abuse was not limited to the enlisted troops.
29. Graham, 117-118.
30. Graham, 112, and Gray, 170. The guns were usually transported in wagons but could be disassembled and carried on mule packtrains. Custer chose neither option. He told Terry the guns might embarrass him. He also declined the offer of additional mounted troops. Apparently, Custer felt his own troops' firepower was sufficient. It is interesting to note that Reno had carried the guns with him on his scout up the Rosebud earlier in the month. He had injured almost a dozen mules in the process. See Gray, 175 and 202.
31. Utley, 174. The famous Anheuser-Busch painting of "Custer's Last Stand" is flawed in this detail, as it shows Custer with a saber in his hand, a weapon he did not have available, Utley, 102.
32. Gray, 132-133.
33. Utley, 201-204, and Gray, 127.
34. Monaghan, 309. In the last day of pursuit, Custer advanced with 800 troops and only a few wagons with tents and food. The cavalry could move quickly with less supply support for about 2 days, then needed to return to the supply wagons.
35. Utley, 167-168.
36. Graham, 49, 53, 54.
37. Gray, 272-273 and 301.
38. *US News and World Report*, Cover Story, 18 Sep 00.
39. Utley, 178.
40. Utley, 68-69.
41. Graham, 150-152.
42. Graham, 117-119.
43. Gray, 200-201.
44. Robert Vaughan, *Yesterday's Reveille, An Epic of the Seventh Cavalry*, New York: St Martin's Paperbacks, 1996, 201-202.

Before any plans can be made to provide an army, logistics must be provided first. History has changed a lot, but logistics has been the crux of every one of these changes; the nail that was missing which lead to the loss of a country lead to a lot of those decisions.

—Major General Hugh J. Knerr, USAAF

Issues in Logistics

Inventory Reduction

Private-sector experience and declining military end strength have motivated the Office of the Secretary of Defense (OSD) to require the Services to reduce inventory. There are some areas—like fuels, medical supplies, and consumable spare parts—where private-sector experience can guide the military in improving its inventory management. However, when evaluating the benefits of inventory reduction, it is important to remember that the Air Force does not manufacture aircraft. Nor is the Air Force exactly like a commercial airline. The Air Force's mission is to be prepared to fight a war that may erupt with little notice.

Not only do military operations differ from those of the private sector, the way inventory is valued differs. The private sector depreciates old inventory. The military appreciates old inventory by valuing it at the last acquisition cost. Such a valuation method gives an inaccurate picture of inventory changes.

OSD set inventory reduction goals based upon the assumption that Air Force inventory should decrease proportional to flying hours. That relationship is not valid even in the simple case of the pipeline and safety-level requirement for peacetime operating stock. Many other legitimate requirements, such as wartime requirements, do not decrease proportionately with decreased peacetime flying hours. Furthermore, the low inflation rates incorporated in inventory goals do not reflect the increased value of the typical reparable spare because of the increase in complexity of newer weapon systems. All those reasons explain why the Air Force has had difficulty meeting its inventory reduction goal.

In fact, inventory value, or even size, should be a secondary issue. The focus on inventory fails to recognize the investment nature of reparables. Reparable spare parts, which make up 90 percent of the inventory value, are meant to stay in the inventory over a long period. By their very nature, they have low turnover. The most important thing to focus on is minimizing new buys. One of the reasons the Air Force started the Lean Logistics program was to reduce its requirement for spare parts. By reducing its repair flow times, the Air Force already has reduced the number of spare parts it needs.

Disposal of on-hand inventory should be done with great care. Disposal decisions should be based upon an economic tradeoff between relatively small storage and management costs and the risk of needing to repurchase items. Indeed, in the early 1980s, the Air Force was reprimanded for disposing of items that eventually had to be bought back.

Focusing on whether the Air Force has been buying too many parts or the wrong parts in the past does not necessarily solve current problems. Certainly, there are some spares in the inventory that the Air Force may never need and should dispose of. However, it is far better to focus management attention on reducing new assets entering the inventory through process improvements and sharp requirements computations.

Virginia A. Mattern,
"Inventory Reduction: When is Enough, Enough,"
***Air Force Journal of Logistics*, Vol VVI, No 2**

Readiness Based Leveling Volatility

Captain David A. Spencer

Background

In November 1998, the Air Force Materiel Command Item Management Division asked the Air Force Requirements Team whether or not the Air Force could reduce the number of readiness-based leveling (RBL) changes and the frequency of RBL runs? Since RBL's inception, supply personnel perceived RBL levels to be more volatile than the previous leveling technique of Standard Base Supply System Repair Cycle Demand Level (RCDL). In other words, RBL seems to change more frequently than RCDL . If RBL were unnecessarily volatile, then more assets would be in the redistribution pipeline, which would result in fewer assets on the shelf for the customers and increased transportation costs.

Our goals in this study were to first reduce the number of level changes by eliminating unnecessary, noncost beneficial level changes, changes where the savings in expected back order (EBO) reduction are not enough to offset the cost of increasing the redistribution pipeline.

The Air Force Supply Executive Board approved the changes in February 2000. The Requirements Team, together with Air Force Materiel Command, fully implemented the changes in October 2000.

Secondly, we sought to reduce the workload associated with RBL runs by reducing the frequency of RBL runs (for example, from quarterly to semiannually) and/or reduce the major command (MAJCOM) and base-level actions to review and load RBL levels.

Function of RBL

RBL allocates the worldwide recoverable item requirement to bases and depot accounts (program depot maintenance [PDM]) so as to minimize EBOs for base-level customers and, therefore, the Air Force as a whole. It is an optimization model that uses marginal analysis to allocate the next level to a base, or depot, that will result in the greatest EBO decrease. Even a small decrease in EBOs resulted in a level change, due to coded algorithms in the RBL model. RBL did not look at the current base level, the previous quarter's RBL allocation, in determining the newest allocation. As a result, RBL changed a level to achieve a reduction of even 0.0001 of an EBO. It also did not consider the cost of the increased redistribution order (RDO) pipeline resulting from these changes and, as a result, potentially placed assets in the RDO pipeline, thus making them unavailable for use. Therefore, potential back orders could have resulted from redistribution of assets among bases to meet the new, changed RBL allocation.

RBL Push Levels

RBL currently pushes levels at least quarterly. RBL can and does push levels between quarterly computations for database corrections and high-priority requirements, such as contingency operations. These levels can and do change based on fluctuations in the D200A-computed worldwide recoverable asset requirement, base demand rates, base pipeline time, depot pipelines, and other base factors. It allocates one national stock number (NSN) at a time across all bases, so a change in one base's pipeline data may cause changes in other bases' levels.

RCDL Changes

The RCDL method can change levels as a result of base demand or base pipeline changes only. It is not affected by other bases, the depot pipelines, or the worldwide requirement. RCDL is computed quarterly and is used for recoverable NSNs for which RBL does not allocate levels (primarily two types of RBL-identified problem items), but RCDL levels do not necessarily change from one quarter to the next. In addition, the SBSS has a rule that dampens RCDL level changes. Unless the absolute value of a new RCDL level is greater than the square root of the old RCDL level, the old RCDL remains in effect. For example, an RCDL of two will not change to one or three since that change is not greater than the square root of two.

Analysis

We conducted our analysis by comparing RBL with other alternative leveling policies to identify a means to reduce RBL volatility. The analysis is divided into three parts. Part one describes the methodology and alternatives for reducing the number of RBL level changes; part two documents the results of the analysis; and part three discusses implementation.

Part One

Using four quarters of historical data, we ran RBL in the two quarters in which we do not receive new D200A worldwide requirements data (April and October, hereafter referred to as the off quarters). We compared the changes in levels from the previous quarter's RBL computation to the current RBL set of levels, RCDL, and alternative models. The D200A requirements data are updated semiannually, and RBL uses that updated requirements data in its January and July runs, the months when the September and March D200A cycle results become available. We wanted to reduce the volatility in the RBL in the off cycles because these cycles have the least number of RBL input data changes.

We chose to allow RBL to run as it does today in the requirements cycles, January and July, because the latest worldwide requirement becomes available in those 2 months. One of the reasons for RBL to change is a change in the D200A-computed worldwide requirement. In the off cycles, one of the sources of volatility is already reduced since RBL uses the same D200A requirements data from the previous quarter. One of the features of RBL is to ensure the sum of the base levels do not exceed the worldwide requirement. So to ensure worldwide requirements and base-level consistency, we should run RBL for all items in the first and third quarters when we receive new worldwide requirements data. For example, we would not want to allocate only part of the worldwide requirement just to reduce levels volatility.

Causes of RBL Changes. Because RBL changes levels as a result of base pipeline changes and changes in the D200A-computed worldwide requirement, one would expect RBL to change more than RCDL; indeed that is what we found. When comparing the January 2000 RBL Central Leveling Summary (CLS) file to the October 1999 file, RBL is more volatile than RCDL; 9 percent of RBL levels changed compared to 7.4 percent for RCDL. Those statistics include all levels, such as zero levels. The percentages are higher when only positive levels are measured.

Table 1 shows the causes of RBL changes by case (each case being a stock record account number-NSN combination as displayed in the CLS file). The table summarizes all level changes that occurred in the period from April 1998 to January 1999. Many of the changes resulted from worldwide requirements changes (4.5 percent exclusively, plus some portion of 62 percent). To ensure consistency and accurately allocate the entire worldwide requirement, we applied level reduction alternative changes only in the off-cycle quarters**.**

Volatility Reduction Techniques. We looked at two different approaches to reducing volatility. One is to only run RBL semiannually, in January and July; in other words, reduce the frequency of runs from quarterly to semiannually. The other approach is to only run RBL for certain items in the off cycles, those for which there is a benefit to changing the levels.

Causes of RBL Changes (Totals from April 1998 to January 1999)	Cases Affected	
Change in Daily Demand Rate (DDR)	0.46%	(502)
Change in Requirement	4.49%	(4,829)
Change in Pipeline	11.03%	(11,840)
Combination of DDR and Pipeline	20.03%	(21,502)
Combination of DDR, Requirement, and Pipeline	62.23%	(66,815)
Adjusted Stock Levels	1.05%	(1,123)
Other	0.71%	(757)
Total	100.00 %	(107,368)

Table 1. Causes of RBL Changes (Cases with Positive RBL Only)

Changes in EBO (Level Changes Only)		
EBO Changes	Number of Cases	Percent of Cases
0.0	23,405	21.8
0.1	18,053	16.8
0.2	11,862	11.0
0.3	8,171	7.6
0.4	6,024	5.6
0.5	4,685	4.4
0.6	3,683	3.4
0.7	3,060	2.9
0.8	2,507	2.3
0.9	2,115	2.0
1.0	1,673	1.6
> 1.0	22,091	20.6

Table 2. Frequency Chart of Level Changes for April 1998 to January 1999

For example, for level changes between April 1998 and January 1999, we looked at the cases that had level changes and noted the EBO reduction.

Table 2 shows that 38.6 percent (21.8 + 16.8) of the RBL levels that changed from April 1998 to January 1999 resulted in less than a .1 EBO reduction. Almost 50 percent had no reduction, or less than .2, and 57 percent had no reduction, or less than .3. So there is little benefit in terms of EBO reduction to changing levels for many of the items that had levels changed in that period. However, some items had level changes that resulted in significant EBO reductions. More than 20 percent had EBO reductions greater than one. New RBL levels should be computed for those items with significant changes.

How do we decide which NSNs RBL should relevel and which changes are significant? How do we decide what amount of EBO reduction is trivial?

NSN Releveling Techniques. We tried two methods to decide which NSNs RBL should relevel because the changes in pipeline data were significant.

Method 1: RCDL. The first method, RCDL change, would let RCDL determine which items to relevel. In method one, RBL recomputed and, if appropriate, changed levels for those items that the RCDL technique would change in the off-cycle quarter. (As previously noted, we recommend that RBL be recomputed for all NSNs in the requirements quarters.) We tested two RCDL techniques, unmodified RCDL and the square root RCDL (the damping rule described earlier that is currently in use) to identify which items RBL should relevel. The advantages of using RCDL are that it changes levels using a technique designed to optimize base levels as a result of changes in base pipeline data, the only data that changes in the off cycles. Also, it did not require major format or program alterations to the RBL data input programs because the RBL model does not require any additional data.

Method 2: EBO. The second method required a change to RBL input data; RBL would need to know the previous quarter's level. For this method, EBO change, RBL relevels items with sufficient EBO reduction. As stated, method two would require changes to the RBL input file and requires RBL to compare last quarter's levels allocation and the resulting EBOs to this quarter's levels and EBOs in order to decide if there is sufficient EBO reduction to warrant a level change.

Whether method one or two is applied, RBL would run every quarter; however, in the off-cycles, RBL would push fewer levels, thus reducing variability.

Part Two

Comparison of Off-Cycle Leveling Techniques. Table 3 provides the results of the various methods using October 1998 data.

Table 3 compares the total EBO and number of levels selected for releveling for five alternatives. The number of levels selected does not mean the levels all change; it shows the number of NSN-SRAN combinations identified for RBL to compute. The first alternative, no RBL, uses the previous quarter's levels in the new quarter. (That is, RBL would not run at all in the off quarter.) There is a 53 percent ([10208-6735]/6735) increase in the number of EBOs compared to running RBL for all items, full RBL. Clearly, not running RBL at all is a poor option.

Next, we looked at running RBL on a relatively smaller group of items to achieve most of the EBO reduction without generating new levels for all NSN-SRAN combinations. For other methods, the resultant EBO is close to a full RBL run, and there were fewer cases selected for releveling. Table 4 compares alternative techniques for running RBL in more detail.

RCDL Technique. Table 4 shows that only running RBL for NSNs that had an RCDL change would not generate any changes for 67,477 NSNs. Full RBL would have releveled 2,844 of those NSNs and achieved an additional 101 reduction in total system-wide EBOs (the sum of all back orders generated by all NSNs leveled by RBL). These 2,844 NSNs show a potential error in using the RCDL method; these additional NSNs should be releveled because they reduce EBOs but were not selected by the RCDL

RBL Off-Cycle Run Options (October 1998)		
Option	Total EBO	Levels Selected for Releveling
No RBL	10,208	None
Full RBL	6,375	535,800
RCDL	6,796	62,775
RCDL Sq Rt	6,869	62,775
EBO (0.1)	6,810	64,833

Table 3. RBL Off-Cycle Run Options

Technique	Unchanged NSNs	Additional Changed NSNs Using Full RBL/EBO Reduction	Changed NSNs	NSNs Full RBL Would Not Have Changed
RCDL	67,477	2,844/101.2	35,113	20,998
SQRT RCDL	70,411	3,992/280.0	32,179	19,212
EBO (0.1)	71,826	4,504/27.3	30,764	-

Table 4. Comparison of Alternative Techniques (October 1998 Data)

method. The RCDL method identified 35,113 NSNs for a possible level change. RBL would not have changed levels for 20,988 of those NSNs identified for change because basically no reduction in EBOs occurred by altering levels.

Square Root RCDL Technique. The square root RCDL method had similar results. Modified RBL did not relevel 70,411 NSNs because they did not meet the square root RCDL criteria. Full RBL would have releveled 3,992 of those 70,411 NSNs and reduced total system-wide EBOs by 280. Just as in the ordinary RCDL technique, these items again reflect potential error from this method. The square root RCDL method identified 32,179 NSNs for RBL to relevel, of which full RBL would not relevel 19,212 of those NSNs.

EBO Technique. The final method identified in Table 4 would relevel items only if there was a change in the EBO of at least 0.1. The EBO (0.1) method identified 71,826 NSNs (all within plus or minus 0.1 EBO) that would not relevel with a total system-wide increase of 27.3 EBOs. Therefore, the EBO (0.1) method identified captured all NSNs for releveling which would generate a reduction in total system EBOs. The EBO (0.1) method identified 30,764 NSNs that would change, although not all SRAN-NSN level combinations would change. The small increase in system-wide EBOs and prevention of trivial changes proves that the EBO (0.1) method is in practice superior to the RCDL method.

Preliminary Findings. Using the EBO method is also theoretically superior to the RCDL method. With the EBO method, RBL would actually measure the EBO impact of not changing levels as a criterion to select levels for change. With the RCDL methods, modified RBL would decide which NSNs to relevel without taking into account the impact on the requirements system as a whole (increase or decrease in total system-wide EBOs). Therefore, the RCDL methods could still make trivial changes, releveling NSNs while achieving little reduction in system-wide EBOs. Using the RCDL method, modified RBL would not make changes for NSNs that probably should be changed. The number of these errors would be small with the RCDL method, but they would occur. So we selected EBO as the means to identify NSNs for releveling.

EBO Threshold. The EBO method is theoretically and actually superior to the RCDL method; about the same number of level changes occurred with fewer EBOs. What EBO threshold should the Air Force use to select NSNs for releveling? In other words, which changes should be considered as trivial changes?

To answer that question, we ran RBL to see the EBO impact if we added a 10-day RDO pipeline to any base that had a level change. If levels change, theoretically, that means an asset must be redistributed from the base with the decreased RBL to another base with an increased level. We measured the EBO increase caused by the added 10-day RDO pipeline, 10 days being the average time it takes for completion of the RDO process. That EBO increase can be considered the cost of a change in levels. The EBO change threshold, the measure of the benefit achieved by changing a level, should be greater than the EBO cost.

Table 5 shows the frequency of the EBO increase as a result of adding the 10-day RDO pipeline. Excluding outliers, changing levels and adding a 10-day RDO pipeline incurs an average 0.08 increase in EBOs. Using 0.08 as the threshold criteria would exclude 80.96 percent of the level changes. We proposed using 0.08 as the threshold criteria. Basically, if the EBO reduction for the level change is not sufficient to offset the 0.08 EBO increase caused by the RDO pipeline, do not change the level.

Using the EBO Technique. With a method to select NSNs for releveling in the off cycles, EBO, and a threshold criterion (0.08), there are still two issues to consider. Should RBL relevel for new users in the off cycles? What about levels to support PDM account needs?

New Users. In RBL, a change in one level usually is offset by a change in another level, since RBL has a fixed amount of worldwide requirements to allocate. Also, RBL currently determines when a base

EBO Change for 10-Day RDO Pipeline			
EBO Change	Number of Cases	Percent of Cases	Cumulative Percent of Cases
0.00	3,002	33.29	33.29
0.01	1,806	20.03	53.32
0.02	745	8.26	61.58
0.03	547	6.07	67.64
0.04	366	4.06	71.70
0.05	313	3.47	75.17
0.06	223	2.47	77.64
0.07	167	1.85	79.50
0.08*	132	1.46	80.96
0.09	131	1.45	82.41
0.10	419	4.65	87.06
0.20	463	5.13	92.19
0.40	223	2.47	94.67
0.60	116	1.29	95.95
0.80	64	0.70	96.66
1.00	30	0.33	96.99
1.00	271	3.01	100.00
*Average increase in EBOs = 0.08			

Table 5. Frequency Chart of EBO Change

will receive a positive level. (RBL can and does allocate positive levels to bases with only one demand, and it can and does allocate a zero level to bases with two or more demands.) Should RBL change levels for new users in the off cycles? For bases with a new adjusted stock level (ASL) or with sufficient demand history to receive a positive level, should RBL allocate to that new user regardless of the EBO impact?

Theoretically, RBL should honor a new ASL once it is approved. It is possible that a new ASL will cause an increase in the worldwide requirement and, therefore, not affect any base levels except the base with the new ASL. However, it is not clear that RBL should provide a positive level to a new demand user unless the EBO criterion (0.08) is met. Theoretically, pushing a positive level to a new user will incur an added redistribution pipeline. We tested three methods of leveling to try to answer these questions. Table 6 displays the results of using these three methods: the EBO-only rule which ignores new ASLs or new users; releveling using EBO and new ASLs; and finally, releveling using EBO plus allocating levels for new users and ASLs.

Running RBL for all items generated 81,563 level changes. Using the EBO (0.08) method only generated 9,341 changes, 11.45 percent of the full RBL changes.

Using the EBO (0.08) method and honoring all new ASLs generated 16,935 changes. (The Air Force Communications Agency implemented its new stockage policy at this time, which explains the relatively high number of ASL changes.)

If new users were exempted from the EBO (0.08) rule, there would be 69,632 level changes representing 85 percent of the changes that would occur from running full RBL. This, in essence, would negate the benefit of the EBO (0.08) rule and create almost as many level changes as are generated today. We proposed using the EBO (0.08) method and honoring new ASLs, while only releveling for new demand users if there is an EBO reduction greater than 0.08.

Comparison of Leveling Techniques for New Users				
Technique	**EBO**	**Percent of EBO Increase**	**Levels Changed**	**Percent of Changed (Levels Changed/81,563)**
Pushing Last Quarter Requirement	6,702	N/A	81,563	N/A
Pushing Last Quarter Levels	9,068	26.10	0	0
EBO > 0.08 only	8,162	21.78	9,341	11.45
EBO > 0.08 w/ASL rule	8,083	20.61	16,935	20.76
EBO > 0.08 w/ASL and user rule	6,739	.55	69,632	85.37

Table 6: EBO Change Analysis

PDM. Should the Air Force apply the EBO (0.08) rule to the D035K depot account (PDM) levels? The PDM worldwide requirement is not based solely on the D035K reported daily demand rate. For example, the depot may repair an end item or exchange for use on another item in next quarter's repair cycle. The other item may not have been repaired last quarter or even last year, which means there may not be any DDR for it in the D035K database. So, RBL's measure of EBOs (based on the reported D035K DDR) may not accurately forecast the change in EBOs in this example. Many PDM items are exclusively used at the depot; therefore, there is no redistribution pipeline. For these reasons, we proposed running RBL without constraints for all NSNs in use at the PDM/DO35K accounts in the off cycles.

Conclusions

We proposed running full RBL twice annually to coincide with the D200A requirements cycle. The January RBL run uses September D200A cycle requirements data and the July RBL run uses March D200A requirements data. An off-quarter (April and October) RBL computation would relevel significant EBO changes as well as ASL and D035K account changes. This results in the relatively lowest total system-wide EBO increase with the fewest number of level changes. Table 7 shows the expected results of the proposed policy.

As indicated in Table 7, RBL currently pushes to the average base, excluding depot retail accounts, more than 1,400 XCA data images (levels). In the off quarters, RBL will only push XCAs for levels that change based on our proposed criteria. For the April and October RBL pushes, bases should only average 100 to 150 XCAs. Our proposal reduced the number of levels pushed in those quarters by 90 percent (1250/1400) and eliminated trivial level changes, those with an EBO reduction of 0.08 or less.

Part Three

Implementation Plan. We briefed our proposal to the Air Force Supply Executive Board, and they approved the changes in February 2000. The Requirements Team, together with the Air Force Materiel Command (AFMC), fully implemented the changes in October 2000. The RBL model was reprogrammed to push XCAs for EBO changes greater than 0.08 plus ASLs and D035K account changes for the off-cycle RBL runs.

Comparison of Levels Pushed (XCAs Released)		
Technique	**Average Number XCAs Using October 1998 Data**	**Average number XCAs Using April 1999 Data**
Present Rules (Full RBL)	1,471	1,403
EBO > .08 w/ASL Rule	153	95

Table 7. Average Levels Pushed Per Base

The proposal requires some changes to programs other than the RBL model. AFMC changed the RBL input file to provide the previous quarter's levels. RBL will only push XCAs on levels that change. However, the Central Level Summary (CLS) file (RBL output file) remains a complete file. The CLS should reflect all levels, even those not changed from the previous quarter. This will facilitate accurate item management at the air logistics centers and MAJCOMs.

The Standard Systems Group (SSG) made a programming change to the SBSS. Currently the SBSS follows up if it does not receive an XCA every 120 days. SSG changed the followup time period to 210 days.

The proposal did not affect out-of-cycle RBL runs and changes. Out-of-cycle, Air Mobility Command forward-supply location level changes will still be honored (XE4 data image with an "I" procedure) without any leveling change constraints. If the item manager identifies an NSN for RBL to rerun (for example, correcting RBL-identified problem items), RBL will run the item without the leveling change constraints. These out-of-cycle changes must also be posted to the CLS. AFMC has plans to post level changes to the RBL web site and the CLS.

Perhaps the most significant lesson of World War II is that the military potential of a nation is directly proportional to the nation's logistic potential. The first hard fact to be faced in applying that lesson is that our resources are limited. The next is that the slightest delay or inefficiency in harnessing our logistic resources may cost us victory.

—Major General O. R. Cook, USA

Logistics Support Planning

A Vision for Agile Combat Support

The development of Expeditionary Aerospace Force (EAF) operations requires rethinking 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.

Developing the Agile Combat Support (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 tradeoffs, such as that between speed and cost or, more generally, between different characteristics valued by the Air Force. These tradeoffs will change as support technologies, policies, and practices change. As a result, ACS planning must be a continuous effort. The system itself must evolve toward a flexible logistics infrastructure that makes the best use of resources and information. It will have to support EAF operations ranging from major theater wars (MTW), to small-scale contingencies, to peacekeeping missions. Further, 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.

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 tradeoffs 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.

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.

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 Southwest Asia (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 LOG 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.

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 tradeoffs 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 advantage of an analytic framework is such that 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.

An important finding of RAND/Air Force Logistics Management Agency 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.

Excerpted and edited from "A Vision for Agile Combat Support," *Expeditionary Logistics 2000: Issues and Strategy for the New Millennium*, July 2000, Robert S. Tripp, Eric Peltz, C. Robert Roll, Lionel A. Galway, Timothy L. Ramey, Mahyar Amouzegar, Clifford Grammich, John G. Drew.

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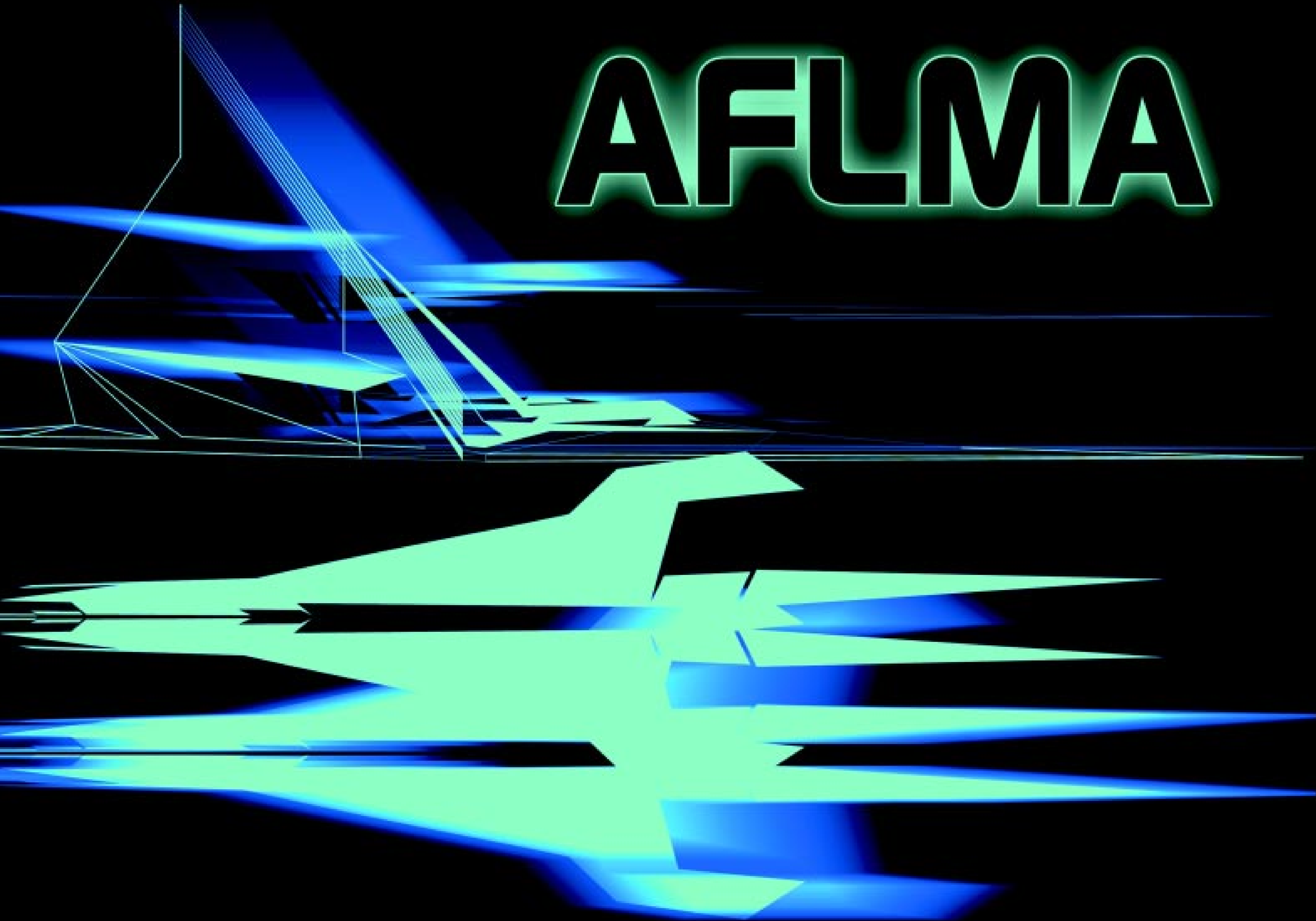
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