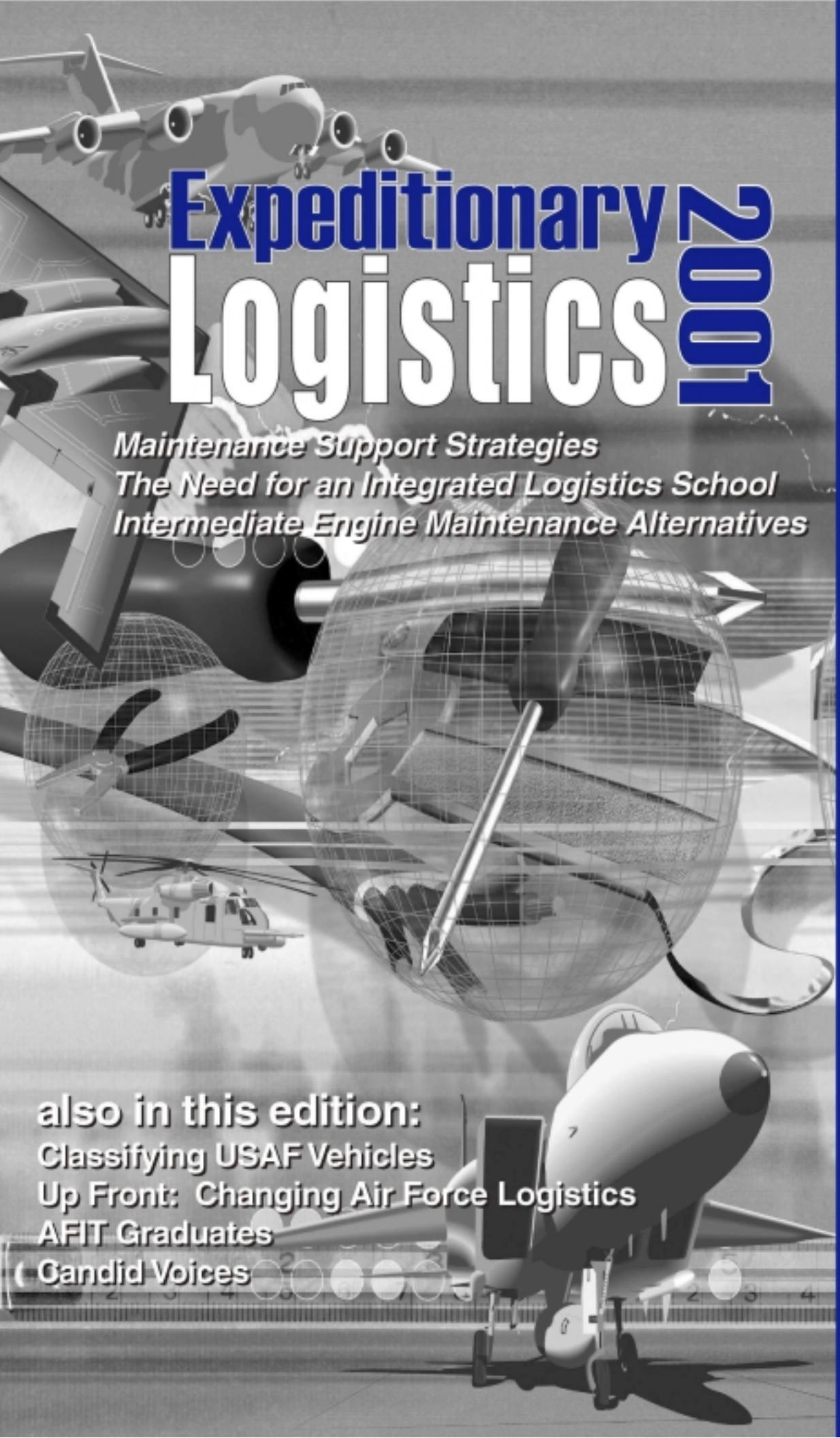

Expeditionary Logistics 2001

Maintenance Support Strategies
The Need for an Integrated Logistics School
Intermediate Engine Maintenance Alternatives

also in this edition:

Classifying USAF Vehicles
Up Front: Changing Air Force Logistics
AFIT Graduates
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Errata, Volume XXIV, Number 4

In Volume XXIV, Number 4, "Growing World of Logistics: A General Theory of Logistics Practices," page 15, Table 1, Definitions of the Discipline of Logistics, the explanatory notes were omitted. They are as follows:

*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.

Reclassifying USAF Vehicles

There is no single way to identify which vehicles are critical to the execution of a wartime or peacetime mission.

Senior Master Sergeant Douglas L. Tucker

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.

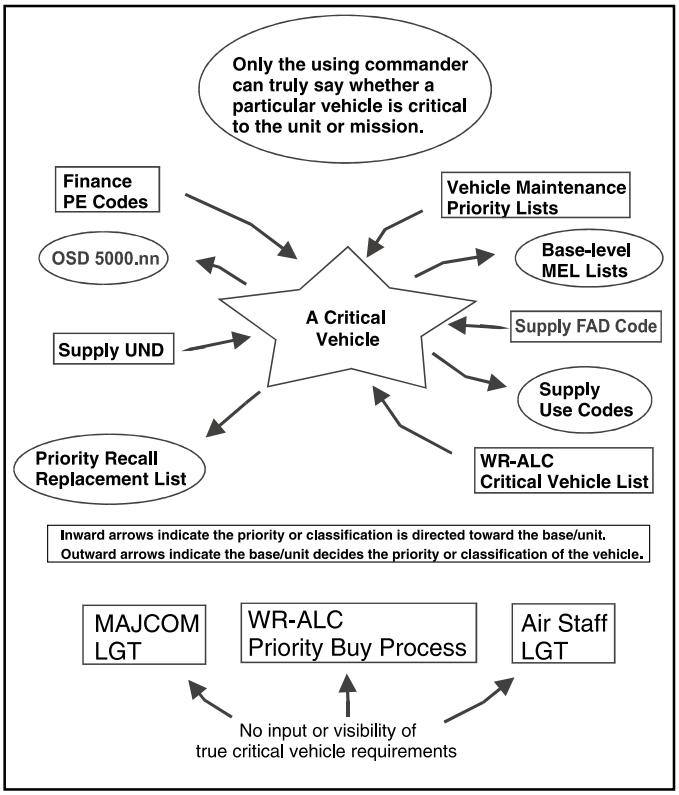


Figure 1. Factors Affecting Classification of Vehicles

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) 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. An 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. So this prioritization seems to be redundant to the MEL. 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 high mobility multipurpose 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. Required by AFI 24-301, *Vehicle Operations*, Chapter 1, the MEL 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. MELS 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 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, MELs only show peacetime vehicle requirements. However, since the Air Force does not have a system to report *all* in-place vehicle requirements, the MEL 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 MELs 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):

- 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 necessa00rily 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

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

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.

Note

1. AF/XPOE Fact Sheet, EAF Implementation, nd.

Sergeant Tucker is a project manager in the Transportation Division, Air Force Logistics Management Agency.

Up Front: Changing Air Force Logistics

Brigadier General Robert E. Mansfield, Jr, USAF
Brigadier General Teresa Marné Peterson, USAF

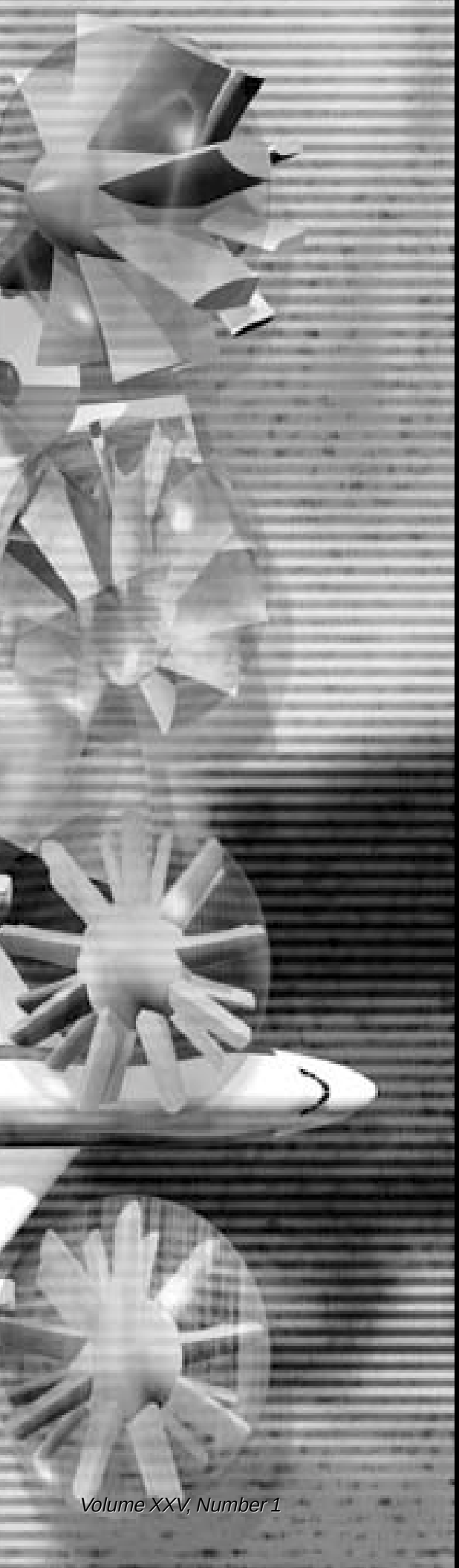
Merging Air Force Supply and Transportation

One of the great strengths of Air Force logistics has been our ability to be in the forefront of innovation in our processes, technology, and organization. We have never been hesitant to change when it meant we would be providing better, faster, cheaper, and smarter support to readiness, the warfighters, and their weapons systems. And we are about to do this again as we test the merger of our supply and transportation squadrons.

This test, as part of the Chief of Staff's Logistic Review recommendations, offers some great opportunities to strengthen our ability to support an expeditionary air force through integrated processes and management. We believe a combined squadron should provide a stronger focus on the day-to-day materiel management process, and when we must deploy, we will have a truly seamless capability.

We know there is always some concern about making big changes. That is why we are testing the concepts at seven bases. More than a year's work has gone into this, so there is quite a bit of thinking behind the merger. The possibilities are exciting for improving our effectiveness and for our profession. We will keep the entire Air Force logistics community informed of the test. Once again, we will be demonstrating—when it comes to Air Force logistics—*no one comes close*!

We know there is always some concern about making big changes. That is why we are testing the concepts at seven bases.



Maintenance Support Strategies

Air Commodore Peter J. Dye, RAF

Geostrategic, economic, and technological changes will make support of air operations, both at home and overseas, increasingly dependent on the flexibility and responsiveness of the military logistic organization. This requires the creation of a highly integrated and agile support chain with global reach.

Military aviation maintenance support strategies are undergoing significant transformation in the aftermath of the Cold War. Organizational changes designed to reduce the cost and development time scales for new weapon systems and enhance the support of deployed, joint operations are set to radically alter military logistics. The main focus is on reducing logistic support costs while improving operational output. This requires the creation of a highly responsive and agile support chain with global reach. A key enabler in this process is the development of partnering arrangements between government and industry.

Existing military aviation strategies have been shaped by a number of environmental factors, of an operational or budgetary nature, not shared with the commercial maintenance repair and overhaul sector. There is, nevertheless, scope for cost reduction through the employment of a variety of business improvement

tools and techniques, including process acceleration and improved materiel and production planning. However, the significant improvements required in the overall cost of ownership can only be delivered if the entire support chain is managed as a coherent entity and optimized end to end.

To date, strategies to shape the support chain have centred largely on outsourcing and rationalisation, relying on competition to deliver the best value for money. Partnering offers the prospect that the varied stakeholders can work effectively together to reduce logistic output costs and improve operational availability. While it is likely that the military logistic organization will continue to embrace depot-level activities, they may well be on a smaller scale than at present and possibly managed under joint arrangements that partner the front-line, fleet managers, industry and in-house repair agencies. Whatever the outcome, the military customer will properly continue to be responsible for determining the required outputs, setting of priorities, and overall integration of the support chain.

The fundamental building block in achieving an effective partnering environment will be the creation of trust between the individual stakeholders. This requires a joint management approach, underpinned by spares-inclusive, long-term contracts with clear gain-share opportunities for all those involved. Success will be measured by a reduction in inventories, faster turn round of aircraft and high-value rotables, more rapid embodiment of modifications, quicker introduction of new technologies, a smaller expeditionary footprint, and greater operational output.

Maintaining military aircraft has always been a challenging and dynamic business, but today it is in the throes of radical change as air forces shape their logistic systems to post Cold War realities. Support strategies have had to be developed that address very different budgetary, technological, and operational requirements. This article examines these issues from a British perspective and draws heavily on the experience of the Defence Aviation Repair Agency (DARA), formed in April 1999, to manage the aviation maintenance and repair facilities of the Royal Air Force (RAF) and the Royal Navy in support of the United Kingdom's (UK) Armed Forces.

Background

A number of recent defence initiatives have had a direct impact on the UK's military aviation maintenance support strategies. Many of the resulting organizational and process changes have yet to be fully realized but, together with the lessons identified in the Gulf War and more recently in the Balkans, are likely to transform the way in which airpower and military capability, in general, are delivered and weapons systems supported both at home and in the field.

Strategic Defence Review

The UK's Strategic Defence Review (SDR), completed in 1998, has been central to shaping future logistic support arrangements for the RAF.[1] The two elements bearing most directly on the existing logistic organization are the Smart Procurement Initiative (SPI)—which seeks to ensure future equipment procurement is *faster, cheaper,*—and *better* and the formation of the Defence Logistics Organization (DLO).

SPI requires a much closer working relationship with industry in the procurement of new weapons systems with an emphasis on a t*hrough-life approach*. The intention is to provide greater scope for tradeoffs between military effectiveness, time. and the whole-life cost of the equipment. Partnering between government and industry is a key enabler, together with improved commercial practices and the creation of an integrated team responsible for project management. The intent is to deliver greater operational capability with improved in-service support and lower through-life costs. More than 130 integrated project teams (IPT) have been formed, bringing together different functions at appropriate points in a project including requirements, procurement, contracts, finance, and logistic staffs within the Ministry of Defense (MoD) with representatives from industry.

There are obvious parallels between the SPI and the US Department of Defense Acquisition Reform and Lean Aircraft initiatives that similarly seek to reduce the costs and length of new weapons programmes by matching best practice and seeking greater partnering with industry.[2]

Defence Logistic Organization

In the past, the individual Services have been largely responsible for their own logistic arrangements. Experience has shown that this does not provide for adequate support of forces engaged in the diverse, joint, deployed operations that characterise today's military environment. The joint commander of deployed forces must be able to exercise effective control over the entire support chain, which should, in turn, be flexible and capable of adjusting rapidly to new priorities. The fundamental change, however, has been the creation of a single, joint logistic organization under the Chief of Defence Logistics (CDL). CDL's remit is to provide support to the UK's Armed Forces that is effective, efficient, integrated, and responsive. The DLO has been structured to achieve these aims through an integrated logistic organization that provides a pan-defence overview allied to greatly strengthened logistics planning. It seeks implementation of best practice, rationalization of functions and capabilities, and the introduction of innovative ideas through the use of information technology and partnerships with industry.

The DLO comprises some 41,000 people, Service and civilian, based at more than 80 locations and with operating costs of nearly £5bn (about 20 percent of the UK's total defence budget). The DLO has an important part to play in implementing the SPI, and 60 of the new IPTs have already formed within the organization. Additional initiatives are in hand, for example, to introduce *lean* principles and rationalise the provision of logistic support. Among the early steps has been the creation of the DARA to repair and overhaul all the UK's military aircraft, both fixed-wing and helicopters.

Environmental Factors

As important as these recent policy initiatives are proving, the fundamental shape of military aviation maintenance has been historically determined by a number of key *environmental* factors. While many of these also impact the commercial sector, the maintenance, repair, and overhaul (MRO) of military aircraft remains distinct in several respects.

Operational Drivers

Operational drivers have always played a significant part in determining military aviation support strategies. In the past,

the focus has been more on brute force than subtle, flexible, and cost-conscious arrangements. While the Cold War lasted, this was an entirely reasonable and affordable approach.

Last year, the RAF was, on average, actively involved in five separate concurrent operations requiring the deployment of some 3,000-4,000 personnel and more than 70 aircraft. These have ranged from continuing support for the North Atlantic Treaty Organization in Bosnia to active operations with the United Nations in West Africa. The focus on expeditionary warfare reflects the significant change in operational posture that has occurred in the last 10 years.

Expeditionary warfare has altered the demands placed on the RAF's logistic system. Rather than the large-scale attritional scenario of the Cold War, smaller, more mobile but highly capable forces are required to be deployed at short notice, possibly concurrently, anywhere in the world. Demanding time scales require logistic units to set up quickly with the minimum deployment footprint yet remain responsive to rapidly changing operational needs. This, in turn, requires the support chain to function in a more agile and coherent manner to ensure operations can commence rapidly and then continue at the required intensity.

Defence Output

Airpower is an increasingly important element in the delivery of military power. As the role of air forces has grown, so, too, has the need for greater weapons accuracy, effectiveness, and discrimination under all conditions and in all weathers. The requirement of modern, coalition warfare has added interoperability, minimum collateral damage, and survivability to the traditional mantra of flexibility, responsiveness, and reach. Increasingly, therefore, the emphasis is on sustaining the highest level of operational capability. This has huge implications for military aviation logistic organizations and has redoubled the emphasis on achieving faster modification embodiment and more responsive supply systems in order to be able to deploy and support the new technologies.

Aging Fleets

A major factor to be addressed in managing support costs is the steady increase in the age of military aircraft fleets. The average age of aircraft in the US Air Force (USAF) front-line fleet is currently around 20 years but is set to rise to nearly 30 years over the next decade, notwithstanding the number of new aircraft types planned to be introduced. Indeed, the average age of the oldest aircraft type in the inventory will exceed 50 years by 2015.[3] Although substantially smaller, the average age of the RAF's front-line fleet, presently around 20 years, is also set to grow (Figure 1).

With increasing age comes increased risk of structural damage, corrosion, and general wear of systems such as utilities, flying controls, and landing gear. The effort to reduce support costs becomes an even greater challenge with an aging fleet where maintenance is dominated by parts obsolescence, fatigue, and an increasing proportion of emergent work driven by unforeseen airframe and engine problems.

Technology

Advances in technology provide the military planner with a significant challenge. The pace of change is accelerating with much of the impetus coming from the commercial sector. This provides obvious difficulties in sustaining future military capability and complicates the task of predicting where technologies will lead. Accordingly, one of the key aims of the SPI is to allow operational capability to be sustained through technological insertion programmes.

On the positive side, new technology is now offering significantly improved reliabilities, notably, but not exclusively, in the avionics field. It has to be added, however, that this can also serve to exacerbate the obsolescence problem, as electronic components are rapidly superseded and no longer supported by the marketplace.

Modification Embodiment

As technology surges ahead and fleets get older, so modification of in-service weapon systems has assumed steadily greater importance. In 1997-1998, the MoD spent £1bn (some 12 percent of all equipment-related expenditure) modifying in-service equipment to sustain existing capabilities and meet emerging or new operational threats. An increasing proportion of aircraft downtimes is utilised to modify and upgrade weapons systems. Unfortunately, the idea of sustaining a single modification standard across an aircraft fleet has largely proved impracticable in the face of limited resources and time constraints. *Fleets within fleets* have emerged as modifications have taken years, if not decades, to be fully realized. For the Tornado (Figure 2), the fastest modifications have taken 4 years from development to fleet embodiment and the slowest 12 years.[4] Clearly, such delays have significant operational, maintenance, and training implications.

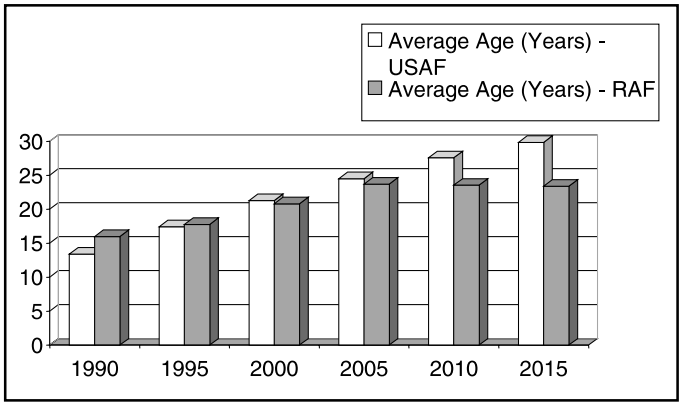


Figure 1. Aging Aircraft Fleets

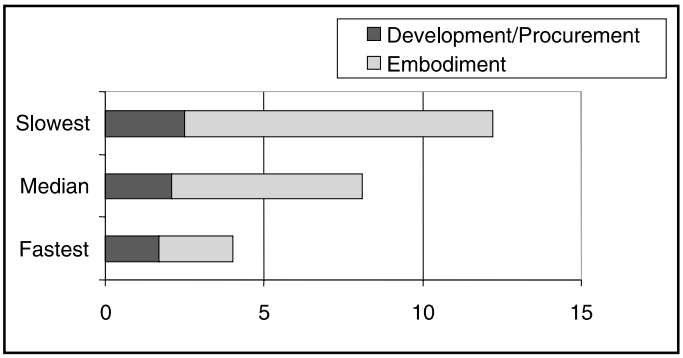


Figure 2. Tornado Modification Time Scales

A secondary, but important, aspect of the increasing pace of modification activity is that it has seen a modest shift from airframe and engine work in favour of electrical and avionic activity. Since the latter often focuses on the cockpit, where access is limited, scheduling and planning have become even more critical for achieving rapid turn-round times.

Budgets

Over the last 10 years defence budgets have fallen in line with a smaller front line and reducing uniformed numbers. In the case of the UK's Armed Forces, the defence budget has fallen from a little more than 5 percent of the Gross Domestic Product in 1985 to less than 3 percent today (Figure 3). In the same period, the size of the RAF has shrunk from a total of 90,000 uniformed people to some 50,000. Sustaining a credible and operationally effective front line under these circumstances represents a major challenge, made all the more difficult by the tendency for defence prices to increase faster than general inflation in the economy.

Given the continuing pressures on the defence budget and the size and cost of the MoD's logistic organization, it will not be a surprise to learn that CDL is committed to reducing the output costs of logistic support by 20 percent over the next 5 years. It is planned that these efficiencies will, in turn, help free the resources needed to sustain the front line's operational capabilities.

Potential for Cost Reduction

The effective logistic support of a front-line squadron is an expensive business, involving a number of key stakeholders and embracing a variety of activities. The total operating budget for the support elements of the RAF's Tornado fleet, comprising more than 300 aircraft, is in excess of £1bn a year, of which the cash cost—excluding fuel, engines, and weapons—totals more than £700M. There are at least five separate organizations with a direct involvement in the management of the Tornado support chain (Figure 4).[5]

For those unfamiliar with the terms employed, the 1st/2d Line describes the engineering and maintenance activities carried out by the front line, within the competence of the operational unit (equivalent to the base and intermediate levels of the USAF maintenance model). Third Line (depot level), in this case the DARA, comprises those activities carried out within the Service but outside 1st/2d Line's competence and, therefore, is generally located off base. The 4th Line embraces all other maintenance activities carried out by external agencies and is, in effect, synonymous with industry.

If these activities are analysed by process, the importance of upgrade work, as a proportion of the overall support costs, becomes readily apparent (Figure 5). While the current midlife upgrade programme for the Tornado undoubtedly influences the pattern of resource allocation, the picture is not radically different to that found in other front-line fleets.

Key Enablers

There are a variety of enablers critical to the effective management of military MRO. Many of these involve the employment of tools and techniques already widely used within the commercial MRO sector. However, because of operational drivers, progress toward best practice has been mixed and implementation patchy.

Software Solutions

The introduction of electronic business systems for military aviation maintenance has been relatively slow compared to the pace in the wider aerospace market. Capacity planning and work scheduling tools, such as Manufacturing Resource Planning (MRP) and Enterprise Resource Planning (ERP), have been increasingly introduced in the last 5 years but are still rare in the military maintenance environment. This applies equally to the use of e-business tools which, while still modest, is growing rapidly in the private sector. In the United Kingdom, the MoD has recently initiated the Defence Electronic Commerce Service (DECS) to assist the DLO to exploit the huge opportunities offered by e-business and to facilitate supply chain integration.

Reduced Turn-Round Times

Shorter turn-round times for maintenance and modification activities not only offer the prospect of higher availability

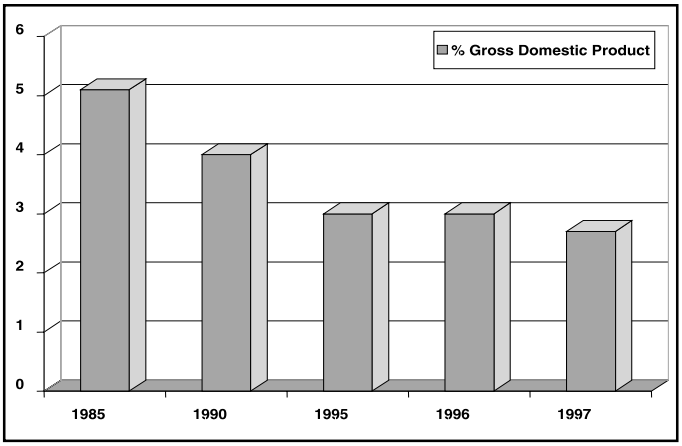


Figure 3. UK Defence Expenditure

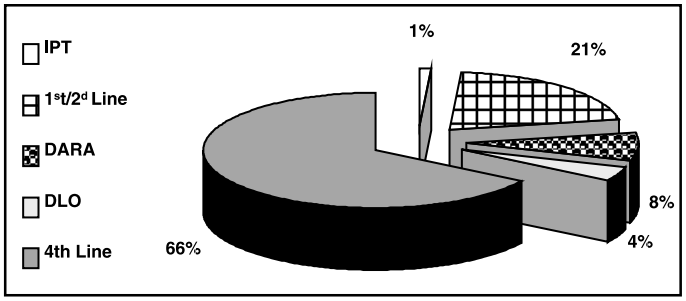


Figure 4. Annual Tornado Support Budget

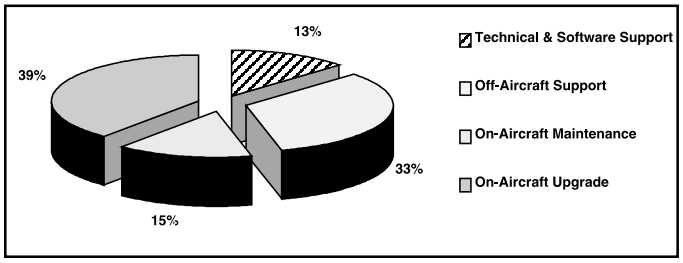


Figure 5. Tornado Support Activities by Process

levels but also attract lower overheads and enhanced production efficiencies. Thus, greater operational capability can be purchased at a lower overall cost to the defence budget. This virtuous circle, however, requires very different organizational and cultural behaviours on the part of the supply chain stakeholders. Inevitably, there will be greater vulnerability to the impact of poor planning or the late arrival of spares, modification kits, and repair information.

Process Acceleration

Process acceleration is central to many of the improvements required to be able to deliver improved logistic support and lower output costs. There is huge potential for improvement across all maintenance processes and levels. Process acceleration seeks to minimize turn-round times, reduce waste, eliminate waiting time, and drive down costs. Within the DARA, notable successes have included reducing the turn- round time for overhaul of the Lynx helicopter main gearbox from 131 days to just 16 days (Figure 6) and for overhaul of the RB 199 high-pressure Compressor, fitted to the Tornado, from 336 hours to 55 hours.

Similar achievements have been delivered in the electronics area and on aircraft maintenance where the current Tornado F3 2000 modification programme has seen a 25 percent reduction in the turn-round time, the elimination of some 600 hours of waste, and introduction of better working conditions through a variety of housekeeping initiatives. It is anticipated that aircraft scheduled maintenance down times can be reduced by 20-40 percent over the next 18 months. The capacity so released can be employed to accelerate the overall maintenance programme and achieve earlier fleet modification embodiment to increase repayment work or to facilitate a reduction in infrastructure costs through rationalisation.[6]

Additional benefits from these initiatives include reduced work in progress; greater ownership on the part of the work force of the processes involved; improved visibility of the key enablers, particularly spares; and the potential for significantly reduced inventories (including high-value rotables) across the entire supply chain while delivering improved availability. To provide some feel for the scale of the potential savings, it should be noted that the DLO's current avionics and electronics inventory is alone valued at £3.2bn of which £2.4bn are reparable, while the overall aviation-related inventory is probably closer to £8bn.

Continuous Improvement

The techniques used to deliver process acceleration also form the basis for continuous improvement programmes intended to sustain the delivery of lower support costs. The major aerospace companies already sponsor such initiatives built around a variety of improvement tools and techniques and waste reduction principles. It seems probable that, as partnering arrangements find wider application, so industry-sponsored programmes such as BAE Systems' Supply Excellence Programme will find wider use in military aviation maintenance management.[7]

Spares and Repair Information

A perennial problem faced in the struggle to achieve turn-round times for aircraft maintenance programmes and

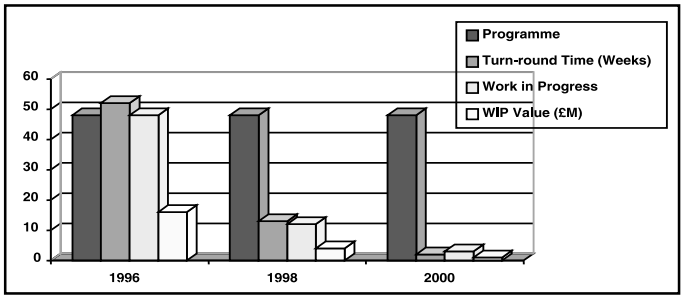


Figure 6. Process Acceleration—LYNX Main Gearbox

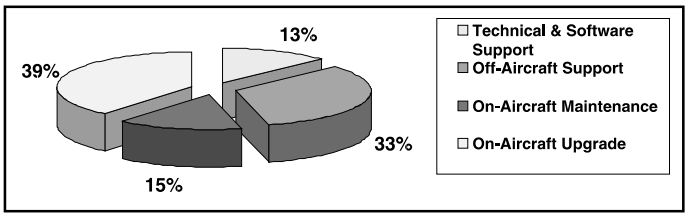


Figure 7. Average Aircraft Programme Delays (By Cause)

military MRO, in general, is the availability of spares, modification kits, and repair information. Spares-related problems account for some 38 percent of the delays currently experienced by the DARA's fixed-wing aircraft programmes (Figure 7). Other significant causes of delay are the late arrival of repair information, inadequate bay support, and engineering problems (emergent work, flight-test failures, and so forth).

Addressing these issues requires a greater emphasis on planning and materiel management within the repair organization in order to provide the wider support chain with credible and timely information on spares requirements. Much of this work can be achieved some time in advance (at least 18 months), and while there are obvious limits as to what can be achieved in the face of procurement lead times and fleet-wide shortages, it is possible to achieve a significant reduction in spares-related delays, particularly if a way can be found to enable the supply base to work together and break away from the traditional consumption-driven approach to spares provisioning.

Support Chain Strategies

Over recent years, a variety of strategies have been employed to shape the military aviation support chain, including competition, outsourcing, and privatization. All these remain important tools for delivering better value for money in the provision of logistic support and have been implemented within the RAF and USAF maintenance organizations with varying degrees of success. However, it has to be said that none have successfully addressed the fundamental need to manage the entire support chain in a manner that balances lower output costs with enhanced military capability.

Part of the difficulty is that there has been a continuing debate, on both sides of the Atlantic, about the strategic need for government-owned military aviation repair facilities. This has tended to cloud the issue and frustrate agreement on appropriate strategies. A further complication has been the development of innovative contracting strategies, such as

Contractor Logistic Support and Prime Vendor Support that seek to address the logistic needs of individual weapon systems. While these total support packages have undoubtedly had an impact on the wider military aviation support chain, their scope has been intentionally narrow and invariably lacking in any overall strategic concept.

As more capability is imbedded in a smaller number of weapons platforms, it becomes all the more important that the highest level of availability is sustained with the lowest possible maintenance downtime. While the individual enablers described earlier are clearly important to more effective maintenance and supply performance, significant operational gain can be delivered only if the entire support chain, across all maintenance levels, is managed as an entity. Logistic arrangements can then be optimized to lower overall support costs and deliver a sustainable operational output. Before looking at how this might be achieved in the future, it may be helpful to look in a little more detail at the strategies employed to date.

Rationalisation

Considerable rationalisation across the military aviation support chain has already occurred. In the last 10 years, the RAF has closed or amalgamated six out of eight logistic depots. Even so, there remains scope for further rationalisation of maintenance facilities in order to derive efficiencies of scale and exploit available synergies. There are self-evident limits to this process, but it seems likely that further rationalisation will occur as integrated logistic support arrangements are put in place.

Even where maintenance activities remain in house, there is a potential for reshaping the logistic organization across the various levels as has been achieved through the USAF two-level maintenance initiative. This has successfully removed a great deal of the intermediate-level capability with a commensurate decrease in the deployment footprint and greatly improved supply chain performance.[8]

Privatization

Total privatization has, to date, remained unattractive in the face of strong strategic reasons to retain an organic (in-house) capability. These have included the need for a surge and reinforcement capability, the provision of an intelligent-customer role, maintaining a benchmark against which to judge industrial performance, and the avoidance of a monopoly situation. Thus, while value for money will always be critical, it seems likely that a proportion of on-aircraft military maintenance will continue to be undertaken in-house, just as the majority (some 73 percent) of airline maintenance is conducted in house.[9]

Competition

Competition in the allocation of specific maintenance contracts has been widely and successfully employed, although there are lingering arguments about the fairness of the process (the *level-playing-field* question). Even so, it is probable that an increasing proportion of off-and-on aircraft maintenance will be competed, although it may prove more effective for partners to agree where the work is actually undertaken rather than allowing a head-to-head fight determine the outcome.

Outsourcing and Contractorization

The economic advantages of outsourcing and contractorization at a time of declining budgets are self-evident. As a result, the level of outsourcing is growing both in the general logistic area and in the direct support of combat operations. Competition, privatization, and the increasing employment of innovative contracting strategies mean that, in the future a significant number of contractor people will be engaged in the delivery of military logistics, including aviation maintenance.[10]

Partnering

While partnering is perhaps the most immature strategy deployed so far, it is perceived as the one offering with the greatest potential. Given the range of stakeholders with direct responsibility for or influence over the supply chain, partnering appears to offer the only practical mechanism to achieve the necessary oversight and control. Of course, this also requires that the proper incentives be put in place. Reducing support costs is as much about changing behaviour as about changing processes. Partnering is critical to achieving the necessary changes in the relationship between customer and supplier and the delivery of cost reduction, better service, and an overall improvement in effectiveness and quality.

Two basic forms of partnering have been developed by the MoD: Project Partnering involving individual projects, a particular service, or an aspect of equipment support and Strategic Partnering involving the building of a long-term relationship to develop technological and strategic initiatives for the generation of income and shared efficiency savings. The aim is to construct a more flexible relationship with the private sector, rather than replacing the traditional contracting and competition processes.

Project Partnering

A good example of Project Partnering is the recent contract between the Tornado IPT and the Original Equipment Manufacturer (OEM) for the provision of Tornado taileron and rudder actuators. The OEM is responsible for the entire support chain from 2^{d} to 4th Line and is contracted to deliver a level of service defined by an achieved flying rate. As a result, aircraft-on-ground rates have fallen, and availability significantly improved. The DARA acts as a subcontractor to the OEM, sustaining an organic capability while contributing directly to a more effective and responsive support arrangement that has achieved real operational benefits. DARA is also acting as a subcontractor to BAE Systems on several aircraft modification programmes, such as the Hawk Fuselage Replacement Programme, won in open competition with industry. It is probable that an increasing proportion of DARA's work will be delivered under these or similar arrangements.

Strategic Partnering

The formation of the DLO has seen the creation of a number of joint MoD/industry tiger teams to review the support of entire weapon systems, classes of equipment, and specific supply chain activities. These ad hoc, multidisciplinary teams have been created to provide a focussed and aggressive review of support strategies drawing on best practice and

seeking innovative solutions. The Tornado Tiger Team—comprising representatives from the IPT, BAE Systems, the frontline, and the DARA—has recently identified ways to deliver more than 20 percent savings in life-cycle costs for the Tornado fleet over the next 4 years. The intention is to create a partnered support solution built on a joint management structure involving all the key stakeholders. The contracting arrangements have yet to be finalized, and other stakeholders may yet join the partnering relationship, but pilot projects have already commenced to confirm the viability of the proposed arrangements. Areas to be examined include process acceleration across a range of high-value rotables, improved strip-to-work ratios for on-aircraft maintenance, integrated software support, joint fleet management, more rapid modification embodiment, and faster provision of technical information and other post-design services.

Future Strategies

It is clear that future military aviation maintenance support strategies will be determined largely by their impact on operational output and cost of ownership. Although it is really too early to claim a significant success for the partnering concept, it is difficult to see an alternative in delivering the necessary efficiencies and end-to-end optimization of the support chain. Contractors are likely, therefore, to undertake an increasing proportion of logistic activities, both at home and abroad. This raises the obvious question of what maintenance responsibilities will remain with the military.

Military Maintenance

Operational maintenance will certainly continue to be performed by military logisticians, as will direct support to the front line. It is possible that these activities will be performed under joint or even coalition arrangements, but they will be undertaken by warfighters. Intermediate- and depot-level maintenance will increasingly be consolidated into a single activity, but it is not clear to what extent the government will continue to own the relevant facilities. That said, there is risk in simply allowing the competitive process to determine the outcome. It is not unreasonable to suggest that, unless the government is able to bring some organic MRO capability to the partnering process, the partnership will not prosper.

All of this tends to suggest that the military logistic organization will continue to embrace depot-level activities, particularly where legacy systems are involved or where strategic concerns remain extant. It is also arguable that 3d Line is inherently better placed to undertake the growing number of life-extension and upgrade programmes. Whatever specific arrangements emerge, these activities will form one element in an integrated, responsive, and agile support chain focussed on delivering the highest level of operational output. Overall management will be exercised jointly under arrangements that partner the front-line, fleet managers, OEMs, and in-house repair agencies.

Success Factors

Planning, contracting for outputs, the setting of priorities, and the overall integration of the support chain will properly remain the responsibility of the military customer. The emphasis will be on spares-inclusive, long-term arrangements with clear gain-share opportunities. Success will be measured by:

- Reduced inventories,
- Faster turn-round times of aircraft and rotables,
- More rapid embodiment of modifications,
- Quicker introduction of new technologies,
- Fewer *fleets within fleets*,
- Better strip-to-work ratios,
- Lower support chain costs,
- Less maintenance manpower,
- Smaller expeditionary footprint, and
- Greater operational output.

Risks

As with any new strategy, there are risks. The fundamental building block in determining a successful partnership with industry is *trust*. As one commentator has observed, "Trust is the currency that makes the supply chain work. If it's not there, the supply chain falls apart."[11] As support chains are more closely integrated and maintenance strategies are better aligned, the more vulnerable is the logistic organization to the impact of inappropriate behaviour. In the past, the risk might have been minimized and resilience enhanced by providing duplicate or alternative in-house capabilities backed up by large inventories. This is neither affordable nor compatible with today's operational needs. In the future, therefore, the main safeguard will be the creation of an environment in which government and industry, both primes and subcontractors, can function coherently, effectively, and harmoniously.

Conclusions

Geostrategic, economic, and technological changes will make support of air operations, both at home and overseas, increasingly dependent on the flexibility and responsiveness of the military logistic organization. This requires the creation of a highly integrated and agile support chain with global reach. The most promising strategy to achieve these aims is based on a joint management approach, teaming the public and private sectors, under long-term partnering arrangements. While it is probable that organic military maintenance capabilities will be retained, particularly to address life-extension and fleet-upgrade requirements, the alliance partners will largely determine the size and shape of the military logistic organization as part of their wider responsibilities for shaping the overall support chain. Success will be measured by a reduction in inventories, faster turn-round times, more rapid modification embodiment, swifter deployment of new technologies, a smaller expeditionary footprint, lower support costs, and greater operational output.

This strategy requires more, however, than the application of just-in-time principles. It embraces commercial express transportation; innovative contracting arrangements including spares-inclusive packages; the application of commercial IT solutions to support materiel planning and inventory management; collective decision

(Continued on page 43)

Logistics Officer Training

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, USAF

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.

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

Expeditionary Airpower

The Need for an Integrated Logistics School

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]

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]

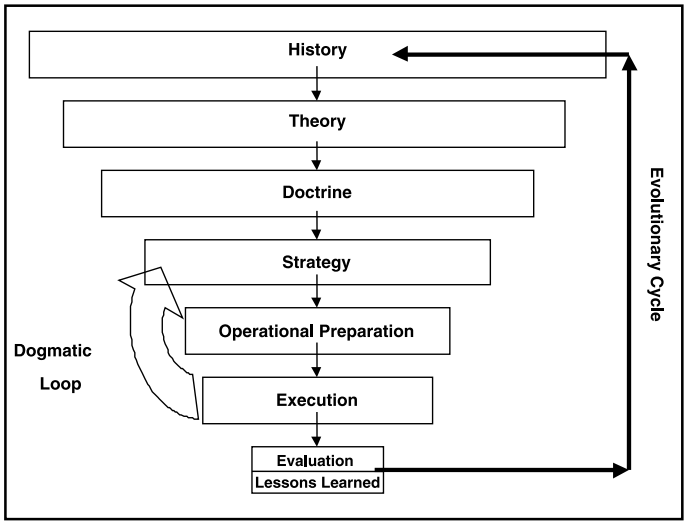


Figure 1. Caffrey History-to-Strategy Model

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]

The increased operations tempo and corresponding personnel tempo required to meet the objectives of Global Engagement drove a need to reduce the number of people 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 people 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

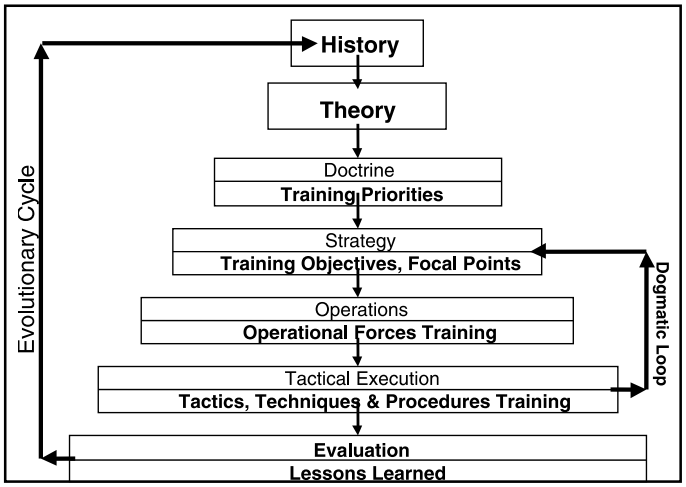


Figure 2. History-to-Training Model

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 operational commanders to change their plans, 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 leads to changes in higher level history and aligns those objectives with congruent strategic, operational, and tactical training requirements necessary for the 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.

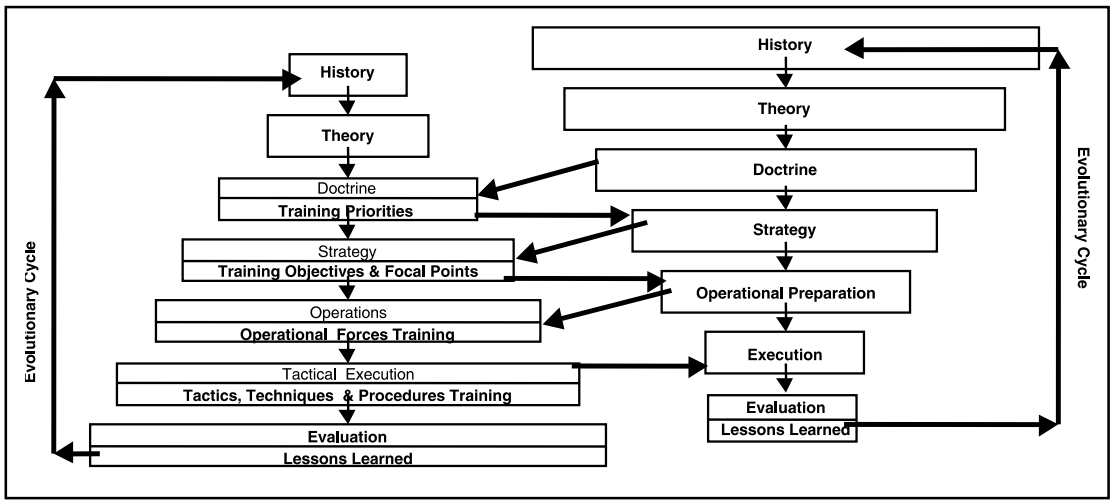


Figure 3. History-to-Doctrine and Training Evolutionary Congruency Cycle

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, 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.

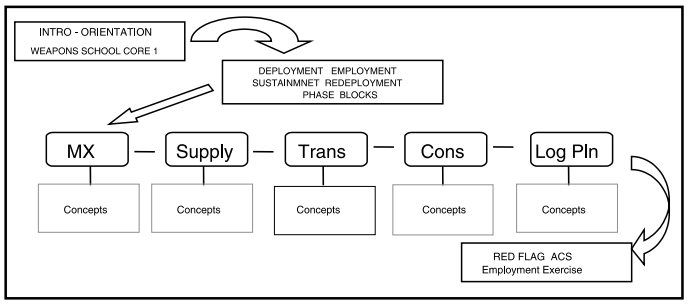


Figure 4. Proposed Agile Logistics School

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(Continued on page 43)

intermediate engine maintenance alternatives

Expeditionary Operations

This study evaluated several maintenance policies for F100-220, F100-229, and TF-34 engines. FSLs for wartime support of fighter engines, with removal rates in the range experienced by the F100 engines, seemed to offer the most attractive policy in terms of serviceable engine availability and its effect on fighter capability. However, the development of any consolidated maintenance structure will require considerable planning from a global, strategic perspective.

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The reorganization of the Air Force into an expeditionary aerospace force (EAF) requires reexamination of many combat support areas. One such area is engine maintenance.[1] Traditionally, the jet engine intermediate maintenance shop (JEIM) has been located where the aircraft were flown from (for example, at the forward operating location [FOL] during deployments) and was under the overall command of the operational commander, a concept that was compatible with Cold War conflicts since units planned to operate from relatively fixed locations. Recent EAF support studies show that, in some cases, centralized repair can provide better performance and allow quicker deployments by reducing initial transportation requirements.[2]

The Air Force has attempted centralized jet engine intermediate repair for various engines several times, albeit with varying success. It centralized JEIM for the Pratt & Whitney F100-220 engine at the San Antonio Logistics Center under the control of the Air Force Logistics Command (later Air Force Materiel Command). Operating units opposed this experiment, and it was ended within 2 years. Nevertheless, reduced fleet sizes and problems in recent years in retaining skilled personnel has led to JEIM centralization for the F110 engine at Misawa AB, Japan; the B1-B engine at Dyess AFB, Texas, and McConnell AFB, Kansas; and the TF-34 engine at Shaw AFB, South Carolina, and several Air National Guard (ANG) units.

With the advent of the EAF, interest in centralization has been renewed because of difficulties in moving a complete airbase structure to a bare base within a very short period of time. Recent experience showed that centralization is useful in some circumstances. Examples are Operation Noble Anvil (the air operation in Kosovo) when logisticians established centralized engine repair facilities at European bases to support forces deploying to new operating locations (southern Italy) or those with limited or overtaxed facilities (Aviano AB, Italy). The JEIM at RAF Lakenheath, United Kingdom, supported several F-15E deployments to other bases. Centralized JEIM at Spangdahlem AB, Germany, supported ANG A-10s operating in Italy and stood ready to supply additional F100 engine repair as needed.

However, working against centralization is the fact that transporting engines for repair is more difficult than shipping other commodities such as avionics whose support might also be centralized. Also, jet engines are subject to numerous time change technical orders, some requiring attention that a centralized repair structure might not be able to perform immediately for a large fleet. Further, the issue of control over maintenance assets remains a significant, if unarticulated, concern to wing commanders.

RAND evaluated several engine maintenance alternatives in support of expeditionary operations:

- The current decentralized-deployed system, in which part of the JEIM at each base deploys with its unit to an FOL to form a deployed JEIM (DepJEIM).
- Decentralized no-deployment, in which there is no JEIM deployment and repairs are done at the home base, even during contingencies.
- A decentralized forward-support-location (FSL) structure, in which each base has its own JEIM but, during war, some personnel from each deploy to a single FSL to support all units in theater.

- A structure combining FSLs with a continental United States (CONUS) support location (CSL) supporting all units in peacetime with JEIM personnel deploying to a theater FSL during war (CSL-FSL).
- CSL-only, in which JEIM is done at a CSL in both peace and war (CSL).

In evaluating these options, a primary consideration was system performance and the ability to respond to unforeseen events. The major elements involved in system performance include spare engines, personnel, and transportation resources. The major focus, however, is on spare engines as a key measurement because sufficient spares ensure that sorties are being executed and provide a hedge against uncertainty and surprises in operating demands.

Simulating Demand and Need

Although helpful for insight into past problems and in choosing alternatives to evaluate, data from previous centralization efforts cannot be used to evaluate the alternatives. This is true for several reasons. First, data on system performance, particularly during conflict and pre- and post-centralization efforts, are limited. Second, several previous centralization efforts faced unique external constraints that may not apply in general situations. Finally, some of the centralization alternatives have not been tried for particular engine types; that is, for engines with repairs that were never centralized (for example, the F100-229), only partially centralized (for example, the TF-34), or not centralized during conflict (for example, the F100-220).

As a result, simulation techniques were used. Engine repair has special characteristics making a simulation model useful for analysis. Sortie requirements change over time, and many measurements such as sorties missed, current spare levels, and queue sizes at key shop points are inherently dynamic. Further, evaluation of alternative systems also requires dynamic analysis of transportation times, capacity, schedules, and management decisions. A simulation model allows analysis of such dynamic variables and how they change during an operation.

Each simulation model is based on the following sequence of events: aircraft are flown from home bases and FOLs to meet peacetime (training) and wartime flying schedules, respectively. After each mission, engines are checked on the flight line, and some maintenance is done. When engines accumulate enough flying hours or when unscheduled maintenance is required, they are removed from the planes and sent to a JEIM facility. Bases and FOLs use spare engines to replace those sent to intermediate maintenance but can miss some daily required sorties if not enough engines are available to meet demands.

In the intermediate shop, engines wait in a repair queue until space and labor are available. Once parts and labor are available, JEIM personnel repair the engines. The labor and physical equipment to work on an engine comprise a *rail team*.[3] The model also accounts for delays in receiving parts that may render an engine not mission capable due to supply (ENMCS).

After repair, the engine is reassembled and flows to a queue for the test cells. After testing, it is moved to final inspection and then returned to the flight line where it is available as a serviceable spare that can be installed on aircraft as needed.

The model makes some further modifications to simulate wartime demand and need. It allows deployed aircraft to fly at rates that vary daily, assumes wartime work hours, and gives priority to deployed units.

The model uses data from the Comprehensive Engine Management System and the Reliability and Maintainability Management Information System and from interviews with personnel at a number of units.

Assessing Repair by Engine Type

For each of the engines examined, intermediate maintenance performance during a single major theater war (MTW) scenario was simulated. The focus was on wartime demand because each structure in peacetime must include the excess capacity needed for war.

F100 Engine Analysis

The F100 series engine is divided into several modules that are designed to be interchanged in the field and can be repaired separately. This article presents results from the analysis of F100-229 and F100-220 engines. The F100-229 is the newest version of the F100 and comprises a rather small fleet. The F100-220 preceded the 229, entering service in the 1980s; this fleet has more than 1,200 engines.

The model for the F100 engines simulates 2 years of operations, with a single MTW beginning after 1 year of peace and ending in 100 days, after which all units return to their home bases and resume a peacetime flying schedule. Resources needed to give equal performance, as measured by missed sorties, are used to compare JEIM alternatives.

For modeling purposes, during peacetime, the F-15s fly at a utilization (UTE) rate of 18 and the F-16s at a UTE rate of 19.[4] At the beginning of the conflict (1 year into the model run period), 48 F-15s and 24 F-16s with F100-229 engines deploy to single mission-series-design bases in a theater of conflict. The larger F100-220 fleets are deployed in stages. The F-15s deploy on day 4 of the contingency, with 12 each going to two F-15 bases and 36 going to a third base. F-16 aircraft deploy for the MTW in four waves, 24 each on days 4, 8, 12, and 16 to four separate bases.

The wartime flying schedule has a 10-day surge, during which the F-15s fly approximately 1.6 sorties per day and the F-16s fly approximately 2.0 sorties per day, followed by a 90-day sustainment period, in which both the F-15s and the F-16s fly about 1.0 sortie per day.

For ENMCS times, historical data from 1997 to 2000 were used. The peacetime total removal rate for the 220 is about 5.0 per 1,000 engine hours on F-15s and 7.5 per 1,000 engine hours on F-16s. For wartime, a single removal rate of five per 1,000 hours was assumed.[5] The removal rate for 229 engines is about five per 1,000 hours in both peace- and wartime. In general, each unit takes all of its designated war reserve engines (WRE) when it deploys.

For each alternative, the throughput capacity of the JEIMs involved is set to be just adequate so that no sorties are missed during the MTW because of lack of engines . The number of rail teams, as defined above, represents the throughput capacity of a JEIM shop in the model. A comparison is then made of alternatives both by the rail teams required[6] to ensure

no sorties lost and the average stock of serviceable spare engines that are available over the course of the war.

For the **deployed-JEIM alternative**, the trace of average serviceable F100-229 spares at each day of the conflict is shown in Figure 1. In this case, 16 total rail teams (12 deployed at the respective FOLs and 4 at home) are sufficient to provide the maintenance needed for simulated MTW operations. The reason for the decline in serviceable spares up to day 60 (negative spares means that engines are not available for all aircraft) occurs because, under the current repair structure, JEIM personnel deploy to an FOL by day 30 of the war and begin work immediately. Test cells, however, are not planned to be ready until day 60, because the concrete slab needed as a foundation to resist the thrust of engines at full power must set for 30 days after pouring. Although no wartime sorties are missed, the number of available engines comes very close to dropping below the threshold needed to maintain sorties.

Deploying more rail teams cannot solve this problem since there are too few WREs for the period when the deployed JEIM is not operating. However, deploying all available spares can improve the situation somewhat. The thicker lines in Figure 1 represent the performance when all spares are deployed for F100-229 engines.

For the **decentralized no-deployment structure** (home support), the JEIM remains at the home base and supports deployed forces from there. Some units currently use this method to support operations enforcing no-fly zones over Iraq. To analyze this structure, one-way transportation for engines between an FOL and JEIM was assumed to be about 15 days.[7] The JEIM moves to a wartime schedule when forces deploy, and deployed forces get first priority for repairs. The resources required and the spares performance are illustrated in Figure 2 (which also shows the WRE curves from Figure 1).

Another variation of decentralized support is the **decentralized-FSL structure**. In this structure, a JEIM shop is located at an FSL in theater and supports engaged forces. During conflict, each home unit deploys some personnel to an FSL ready to begin operations when the JEIM personnel arrive. Transportation between FOLs and the FSL takes about 2 days.[8]

An alternative FSL arrangement is the **CSL-FSL structure** with some CSL staff performing peacetime JEIM and some deploying to an FSL during war. Total staffing and resource requirements for this case are derived from those identified for the FSL above plus those needed at the CSL during war to support nonengaged forces. The performance of this alternative is the same as that of the decentralized-FSL alternative since the source of resources has no effect on the repair process once established and running.

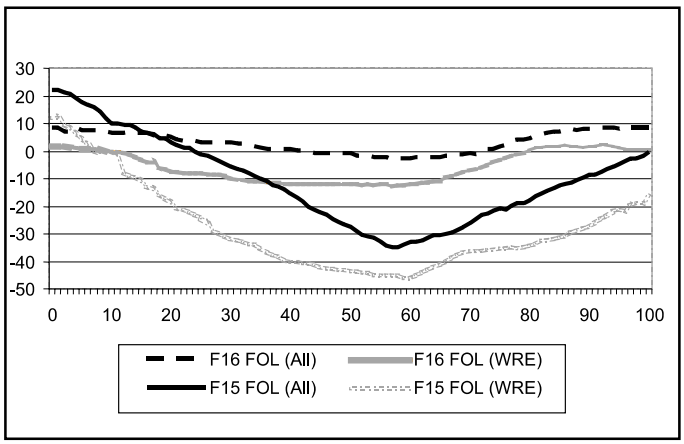


Figure 1. F100-229 Decentralized Deployed MTW Spares Performance

The final alternative is **complete centralization** in a single CSL. The CSL would be 2 to 4 days from each CONUS location and about 15 days from forces engaged in an MTW. The simulations for this case also show that using only the specified WRE will leave spare levels dangerously low.

Figure 2 illustrates the results for F100-229 engines for all alternatives. For the deployed JEIM scenario, as many as 12 F-16s and 22 F15s can be without serviceable engines. In contrast, in the worst day of the conflict, only a few F-16s and about 11 F-15s are with holes in an FSL scenario. The table in the figure indicates the total number of resources (rails teams and test cells), retained resources, and deployed resources for all the scenarios.

These results indicate that FSLs are superior for supporting a fast-breaking conflict. Other structures do not perform as well because of their time requirements. Those with more centralization require too much transportation time for maintaining adequate thresholds for sorties. Those with less centralization develop a large backlog of engines during MTWs and, hence, a dangerously low level of spares before a deployed JEIM can begin repairs. Note that, although recovery is ultimately more complete over the war for the deployed JEIM, it requires more resources.

Figure 3 shows similar spares analysis for the 220 engines. The performance for the decentralized system declines through the first 60 days of the contingency but recovers following DepJEIM establishment. Performance for the consolidated options degrades for about the first 30 days and then stabilizes, after which spares performance for the FSL option becomes better than that for the other consolidated options.

Transportation Requirement for F100 Engines

It is somewhat difficult to determine the transportation requirements for the decentralized-deployed case. The latest Air Force unit type code (UTC) list describes several different F-15 and F-16 independe0nt (that is, capable of operating by themselves) JEIM UTCs ranging in weight from 25 to 50 short tons.[9] A very conservative assumption that 50 short tons must be moved to the F-16 FOL and 100 short tons to the F-15 FOL means that the airlift requirement for this option is 1.2 C-5 sorties for the aircraft with F100-229 engines during the first 30 days of the MTW.[10] JEIM deployment for the 220 engine requires movement of 250 short tons or 3.8 C-5 equivalents.

The decentralized no-deployment structure requires intertheater transportation between FOLs and JEIM shops. It is estimated that an average of 40 F100-229 engines would be returned during the first 2 weeks of the MTW and 10 engines per week would be returned during sustainment operations. This equates to a lift requirement that would need 1.7 C-5s each way during the first 2 weeks of the war and 6.8 C-5s for the remainder of the war. Fighters with 220 engines require an average of 1.6 C-5 transportation equivalents per week during the MTW. These numbers reflect the gross capacity

needed, presumably supplied by an ongoing airlift operation that shares transportation space with other needs.

The transportation requirement for the FSL scenario is the same for the decentralized no-deployment scenario. The decentralized-FSL structure, however, can meet this requirement with intratheater assets or about 10 per week for the 229 engines and about 24 per week for the 220 engines. The complete result of the transportation analysis is shown in Table 1.

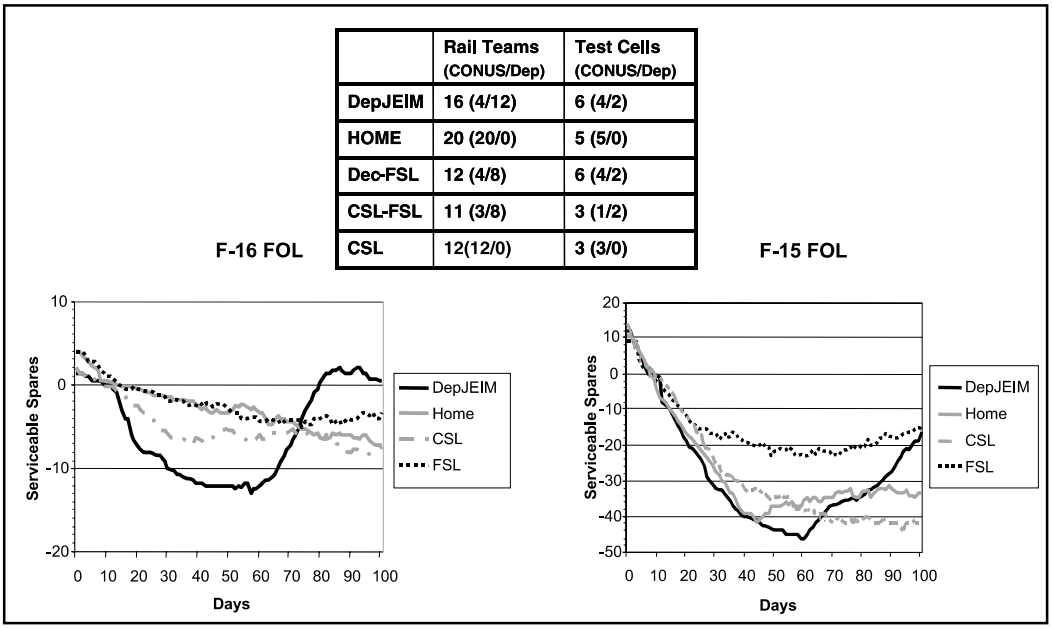
TF-34 Engine Analysis

As part of the study, the usefulness of alternatives for repair of the TF-34 were also examined. The T-34 is a nonmodular engine that entered service in the late 1970s. The aircraft it powers, the A-10, has been retained in greater numbers than planned following its performance in Iraqi and Kosovo operations. Because of its smaller thrust and lack of an afterburner, it has a lower removal rate than the F100 engines analyzed.

Current repair for the TF-34 features both centralized and decentralized structures. JEIM for Spangdahlem AB and for Pope AFB, North Carolina, for example, moved to Shaw AFB when A-10s were withdrawn from Shaw, freeing JEIM capabilities. As with the other engines, a comparison was made with the performance of centralized and decentralized alternatives in a scenario featuring a single MTW, using current spare levels and empirical ENMCS and repair times from the Shaw JEIM.[11]

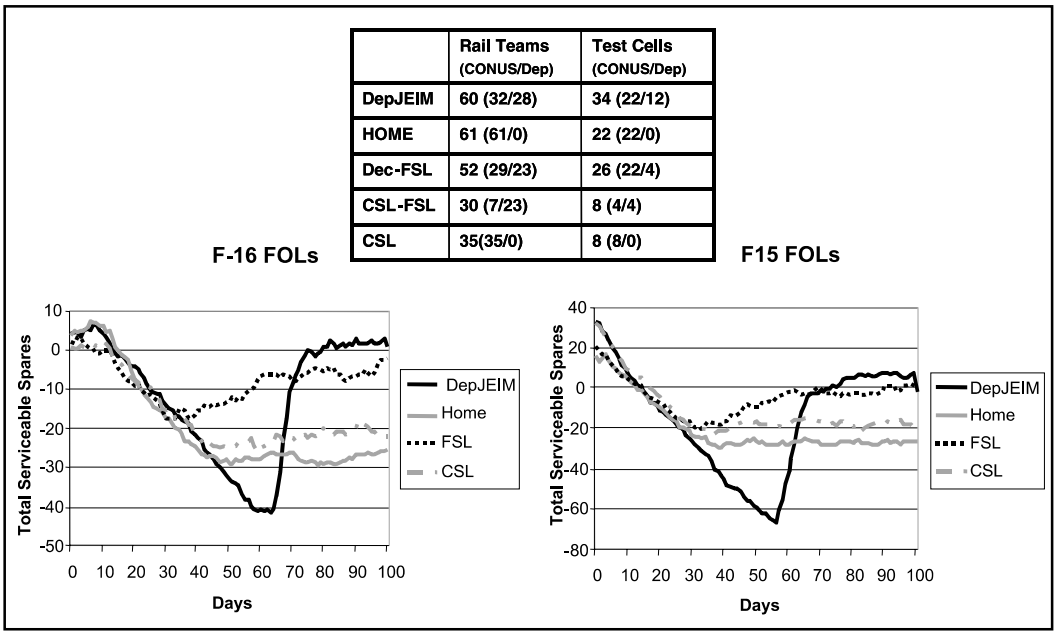
A similar MTW scenario was used for this engine. Simulated JEIM performance showed a slowly declining number of spares available over the course of the conflict. This pattern is primarily due to an interaction between the number of available spares and the relatively long time needed to repair the TF-34. Repair at consolidated locations or at home bases functions best, providing the highest number of spares throughout the conflict.

A deployed JEIM for the TF-34 requires 3.5 C-5 equivalents to meet requirements. The options in which repair takes place in CONUS require an average of .25 C-5 equivalents weekly throughout the MTW. The options in which repair takes place at an FSL require an average of three C-130 equivalents weekly throughout the MTW. Total transportation resources needed for these options are only slightly higher than those needed for the DepJEIM and are concentrated after the first month when airlift is more available.



	Rail Teams (CONUS/Dep)	Test Cells (CONUS/Dep)
DepJEIM	16 (4/12)	6 (4/2)
HOME	20 (20/0)	5 (5/0)
Dec-FSL	12 (4/8)	6 (4/2)
CSL-FSL	11 (3/8)	3 (1/2)
CSL	12(12/0)	3 (3/0)

Figure 2. Spares Performance by Repair Structure in MTWs for F100-229 Engine



	Rail Teams (CONUS/Dep)	Test Cells (CONUS/Dep)
DepJEIM	60 (32/28)	34 (22/12)
HOME	61 (61/0)	22 (22/0)
Dec-FSL	52 (29/23)	26 (22/4)
CSL-FSL	30 (7/23)	8 (4/4)
CSL	35(35/0)	8 (8/0)

Figure 3. Spares Performance by Repair Structure in MTWs for F100-220 Engines

Dealing with Uncertainty

The previous analyses assume relatively fixed-removal rates, repair and ENMCS times, spare levels, and sortie rates with values, in most cases, corresponding to current experience. These values will not always be fixed. Different scenarios may require

different flying profiles. Removal rates may change. As a result, the effects of changes in some of these variables were explored.

Peace	War	Transportation a/c Equiv (Surge/Sustain)	
		F100-220	F100-229
Decentralized	Deploy	3.8 C-5 (once)	1.2 C-5 (once)
Decentralized	No Deploy	2.8/19.9 (1.6/wk) C-5	1.7/6.8 C-5
Decentralized	FSL	43/299 (24/wk) C-130	32/122 C-130
CSL	FSL	43/299 (24/wk) C-130	32/122 C-130
CSL	CSL	2.8/19.9 (1.6/wk) C-5	1.7/6.8 C-5

Table 1. F100 Series Wartime Transportation Requirement

Transportation

Transportation assumptions may be the most critical and subject to the most contention, particularly as the Air Force uses more joint transportation and defense agencies expand transportation contracts with private carriers. Figure 4 shows how transportation time affects missed sorties in an FSL repair structure for the F100-229. If the one-way transportation time is 2 days or less, as assumed, sorties missed because of transportation delays are negligible. For each additional day required for transportation, however, missed sorties increase, especially for the F-15 unit.

Figure 5 shows similar effects for the home-base repair performance for the F100-229. If transportation between FOLs and home exceeds 15 days, missed sorties increase substantially.

TF-34 repair is less sensitive to transportation times because of its low removal rates and different repair structure.

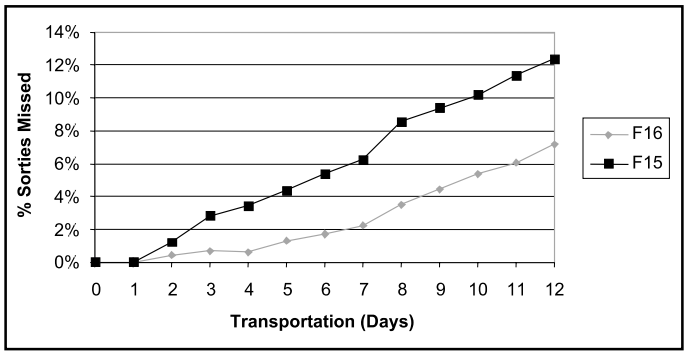


Figure 4. Effects of Transportation Time on FSL JEIM Performance for Deployed F100-229 F-15 and F-16 Units

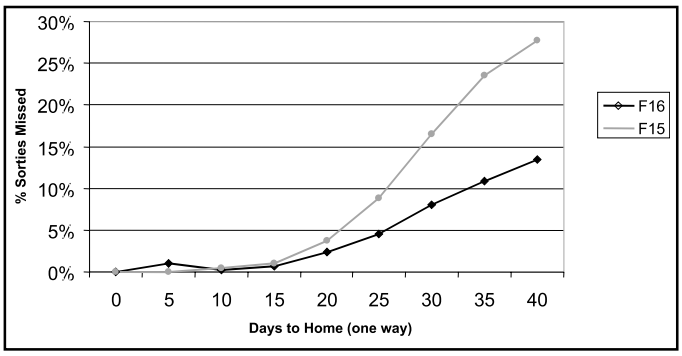


Figure 5. Effects of Transportation Time on Home-Base JEIM Performance for Deployed F100-229 F-15 and F-16 Units

Removal Rate

Removal rates may increase as engines age or decline and as new maintenance practices such as reliability-centered maintenance take effect.

For the F100-229, comparatively few sorties are missed if removal rates remain below ten per 1,000 flying hours or twice that assumed. Figure 6 shows that, at higher removal rates, the FSL alternative continues to perform better than the other alternatives.

To avoid missed sorties, the removal rate for the F100-220 cannot exceed the assumptions by much. In fact, if the removal rate for the F-16 during war remains at its current peacetime level of 7.5 per 1,000, only an FSL JEIM structure will avoid missed sorties. System performance will be worse and missed sorties highest with the DepJEIM.

Even with removal rates substantially lower than those assumed, the DepJEIM cannot perform as well as an FSL structure. Figure 7 shows available spares for the 220 engines on F-15s in an FSL structure with a baseline removal rate of five per 1,000 hours, for a DepJEIM with the baseline rate, and for a DepJEIM with lower removal rates. Even at a removal rate of two per 1,000 engine hours, the DepJEIM performance is worse than that for the baseline FSL case in days 50 to 65 of the MTW. The results for the F-16 are similar; however, only at the lowest removal rates does DepJEIM become competitive with the baseline FSL case.

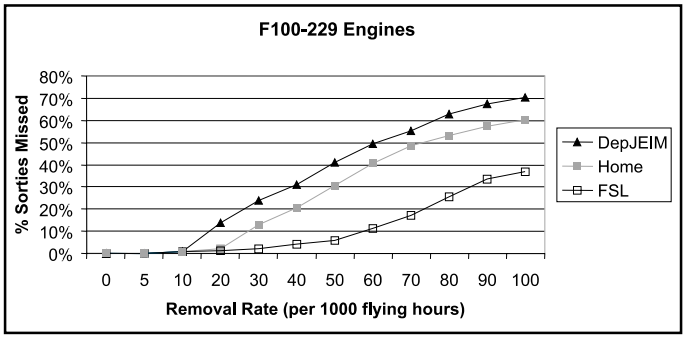


Figure 6. Effects of Removal Rate Variation on JEIM Structures for All F100-229 Engines

Conflict Intensity

The basic scenario assumes that surge operations will last 10 days. MTWs with longer surges will miss sorties if other operation parameters remain unchanged. For example, for the F100-229 engine being repaired by the decentralized-deployed alternative resourced for the scenario, a 20-day surge will lead to a missed sortie rate of about 10 percent, while a 40-day surge will lead to a missed sortie rate of about 20 percent. The model indicates the FSL alternative would better adapt to longer surge operations with fewer sorties missed.

Conclusions and Recommendations

This study evaluated several maintenance policies for F100-220, F100-229 and TF-34 fighter engines. For an MTW, deploying the JEIM to an FOL is too slow. For each engine, the deployed JEIM had the worst performance during the first part of the war

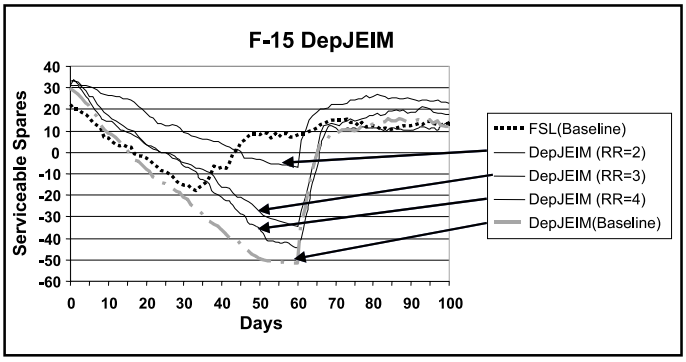


Figure 7. Effects of Removal Rate Variation on JEIM Structures for F100-220 Engines on F-15 Aircraft

because of the time it takes to establish a JEIM shop, particularly the test cell. Constructing test cells at potential FOLs could reduce this time but would reduce flexibility for expeditionary operations since it is not feasible to carry out this program for all possible FOLs. A deployed JEIM also requires transportation resources that may be needed for other parts of the deployment, especially in the early stages of a conflict.

FSLs for wartime support of fighter engines, with removal rates in the range experienced by the F100 engines, seemed to offer the most attractive policy in terms of serviceable engine availability and its effect on fighter capability. The speed with which FSL repair can begin wartime operations and its short transportation pipeline are well suited for expeditionary missions. An FSL JEIM also requires fewer personnel in the critical early days of combat and performs better in the face of uncertainties.

However, consolidating repair operations for F100 engines will require a dedicated, responsive, and substantial intratheater transportation system during an MTW, particularly during surge operations. Transportation delays will lead to loss of capability. The development of any consolidated maintenance structure will require considerable planning from a global, strategic perspective.

The low removal rates for the TF-34 make centralization of its maintenance operations easier. Continued centralization of TF-34 repair appears to be the best policy, supported by both analysis and experience at Shaw AFB, even to the extent of using CSLs to support MTWs. However, as a hedge against transportation uncertainties, some TF-34 repair capability might be included in an FSL.

Finally, there are a number of qualitative considerations to bear in mind when considering centralized engine repair.

- Past centralization attempts have had a mixed record on responsiveness to units. Other questions of organizational control are also contentious. Such issues must be settled early and clearly for any centralization effort to succeed.
- JEIM consolidation will require attention to flight-line experience so that flight-line diagnosis is not compromised. If the flight line requires relatively more experienced personnel when not collocated with JEIM, this will offset some of the resource economies of scale suggested by the analysis. Alternatively, since the JEIM currently backs up the flight line, if flight-line experience is not maintained or increased, removal rates may increase.
- If support is centralized for wartime but not for peace, the Air Force will have to ensure that the transition from one structure to another is smooth. This will require rethinking areas such as information systems, command relationships, and communication requirements and, most important, practicing real centralized maintenance in exercises and deployment.
- There are several other potential advantages to centralization such as improved training and reduced ENMCS times. In these areas, this analysis has been conservative in that centralized alternatives have used the same skill levels and ENMCS performance as the decentralized ones.

Notes

1. At the request of the Air Force Deputy Chiefs of Staff for Air and Space Operations and Installations and Logistics, RAND has issued a series of studies on the issues raised by the need to adapt the combat support system for expeditionary operations. Previous analyses published in the *Air Force Journal of Logistics* include Lionel A. Galway, et al, "A Global Infrastructure to Support EAF," Summer 1999; Robert S. Tripp, et al, "Strategic EAF Planning—Expeditionary Airpower Part 2," Fall 1999; Eric Peltz et al., "F-15 Support Analysis—Expeditionary Airpower Part 3," Winter 1999; Robert S. Tripp, et al, "A Vision for Agile Combat Support—Expeditionary Airpower Part 4," Winter 1999; Amatzia Feinberg, et al, "EAF Support Challenges—Expeditionary Airpower Part 5," Spring 2000; John B. Abell, et al, "Alternate Munitions Prepositioning—Strategy 2000," Summer 2000; and David A. Shlapak, et al, "Global Access—Strategy 2000," Summer 2000.
2. The work reported in this article is described in more detail in M. Amouzegar, et al, *Supporting Expeditionary Aerospace Forces: An Analysis of Jet Engine Intermediate Maintenance Options*, RAND, forthcoming.
3. Engines are mounted on *rails* for repairs. A rail team is defined as a minimum number of people needed to work on an engine in a two-shift day. For example, for 229 engines, a rail team is five people per shift or a total of ten people.
4. These usage rates are the current Air Combat Command (ACC) targets. As of this writing, other factors were forcing the actual usage for ACC units below this target. Recent research suggests that the ACC target may be too low to maintain pilot proficiency and allow newer pilots to acquire needed skills (see William W. Taylor, S. Craig Moore, and Charles Robert Roll, Jr, *The Air Force Pilot Shortage: A Crisis for Operational Units?* RAND: Santa Monica, California, MR-1204-AF, 2000.
5. With higher removal rates, there would not be enough spares to support an MTW in all but one of the repair structures studied.
6. The relative rankings of the alternatives are valid because each alternative faces the same scenario. These numbers do not represent an absolute size of a real world JEIM shop because they do not take into account various factors such as sickness, other duties, and so forth. The model is not a maintenance-sizing model.
7. This assumption has stimulated considerable comment at briefings to various audiences. Some argue that current transportation times to locations outside CONUS can be substantially longer than 15 days, particularly for large items like engines. Others argue that planned changes to DoD transportation policies will result in shorter times. Given current constraints on military airlift and assumptions of how an MTW would likely stress the airlift system, the assumption of 15 days for one-way transportation time is retained.
8. This is more of a requirement than an assumption since more than 2 days of transportation time will affect the sortie generation.
9. Manpower and Equipment Force Packaging System Summary Report, 27 Oct 99.
10. This does not include the resupply transportation for spare parts and modules required for support of deployed JEIM shops.
11. Shaw JEIM was used because a large number of engines are repaired there and the distributions across all JEIMs of repair and ENMCS times were largely similar. Intermediate repair for the TF-34 is a mixture of *quick turn* and more comprehensive repair.

Dr Amouzegar, Dr Galway, Ms Geller, and Dr Tripp are analysts at RAND. Mr Grammich is a communications analyst at RAND.

AFIT GRADUATES A NEW CLASS OF LOGISTICIANS

On 20 March 2001, the Air Force Institute of Technology's (AFIT) Graduate School of Engineering and Management graduated a class of 25 officers with a Master of Science in Logistics Management, including two officers from Turkey and one from Brazil. This is the first class to graduate since AFIT's reorganization and the realignment of the logistics program under the Department of Operational Sciences. The program is 18 months long and prepares students to apply quantitative and analytical methods to assist high-level decision makers in the management of logistics, transportation, maintenance, and inventory systems.

Of the 25 officers, three earned distinguished graduate distinction: Captain Steven L. Martinez, Captain Paul G. Filcek, and Captain Christopher Boone. Each of these officers also earned additional prestigious awards as the *best of the best* of the 190 graduates in their class.

Captain Martinez was the winner of the Lieutenant Edwin E. Aldrin, Sr, Award (sponsored by the Air Force Association Wright Memorial Chapter), given in recognition of the student who has displayed exceptional leadership characteristics. The award is given to the student who has continuously demonstrated high-quality academic accomplishments, military decorum, leadership capability, and the ability to work with faculty as well as fellow students. Captain Martinez was also the winner of the International Society of Logistics Jerome G. Peppers, Jr, CPL, Outstanding Student Award, given to a member in each graduating class whose academic record and contributions to the field of logistics are judged superior.

Captain Paul G. Filcek was the winner of the Louis F. Polk Award (sponsored by the National Defense Industrial Association [NDIA]). This award is given in recognition of the student who has made advanced contributions in a professional field in direct furtherance of the objective of NDIA. The honoree reflects the highest standards of academic and professional accomplishment during participation in the Institute's graduate programs.

Captain Christopher Boone was the winner of the Dr Anthony D'Angelo Superior Mentorship Award, sponsored by Sigma Iota Epsilon (the national management honor society), given to a member in each graduating class in recognition of the student whose leadership and mentorship contributions to fellow students are judged superior.

Following are the 25 graduates, along with the title of their theses, their faculty advisors, their research sponsors, and a brief description of the impact of their theses work. Copies of the research reports will be available from the Defense Technical Information Center website at www.dtic.mil.

- Anaya, Victor A. "Analysis of the Next Generation Small Loader (NGSL) in Reducing the Mobility Footprint," AFIT/GLM/ENS/01M-01. Faculty Advisor: Dr William A. Cunningham III. Sponsor: Air Mobility Command Systems Requirement Branch. Analyzed the impact of replacing the 25K/WBEL combination with the NGSL. Personnel savings are 15 authorizations, total dollar savings are $848,706/year, and footprint savings during deployment are one C-130 equivalent.
- Boone, Christopher A. "Development of an Instrument to Identify Unique Supply Officer Knowledge," AFIT/GLM/ENS/01M-03. Faculty Advisor: Major Marvin A. Arostegui. Sponsor: Air Force Directorate of Supply. Research led to the development of an instrument for identifying the unique knowledge of Air Force supply officers, which will lead to a value determination of this knowledge and the supply career field.
- Burghard, Darrell O. "Logistics Transformation: Centralizing Air Force Logistics Information Command and Control," AFIT/GLM/ENS/01M-04. Faculty Advisor: Major Marvin A. Arostegui. Sponsor: Air Force Materiel Command (AFMC) Logistics Plans, Programs, and Integration Division. Working with the AFMC Logistics Group, a value-based evaluation tool was developed that can be used to establish core requirements for an ideal centralized logistics information system and evaluate alternative systems.
- Buyukacar, Murat V. "Effects of Alternative Performance Criteria upon the Composition of Air-Transportable Spare Parts Kits," AFIT/GLM/ENS/01M-05. Faculty Advisor: Lieutenant Colonel Alan W. Johnson. Sponsor: None. Developed a model to investigate the problem of reducing readiness spare parts (RSP) packages for deployment. Results were superior to a single criterion in terms of RSP selection process, analyzing cost versus airlift requirements tradeoffs, and achieving cost reductions on selected RSPs.
- Colvard, Michael J. "An Analysis of the Interaction between the J3 and J4 War-Planning Staffs During the Phases of Crisis Action Planning," AFIT/GLM/ENS/01M-06. Faculty Advisor: Major Stephen M. Swartz. Sponsor: Defense Advanced Research Projects Agency. Developed a dynamic decision support tool for the campaign planner to identify and define knowledge requirements and improve and implement the right information systems at the right place. This model significantly reduced deployment, execution, and redeployment time lines.
- Commenator, Mark A. "Aircraft Maintenance Performance: The Effects of the Functional Decentralization of On-equipment Maintenance," AFIT/GLM/ENS/01M-07. Faculty Advisor: Lieutenant Colonel(sel) Stephan P. Brady. Sponsor: None. Analyzed the organizational structures of Air Force aircraft maintenance units and the resulting impact on unit performance, giving managers a tool to use in identifying factors that best improve aircraft maintenance performance.
- Downing, Jonathan G. "United States Air Force Graduate Degrees from 1990 to 2000: A Comparison," AFIT/GLM/ENV/01M-01. Faculty Advisor: Major Mark A. Ward. Sponsor: None. Investigated the nature and percentages of Air Force line officer graduate degrees over time to determine if the current levels of nontechnical and technical degrees are sufficient to meet Air Force needs.
- Filcek, Paul G. "A Quantitative Decision Support Model to Aid Selection of Combat Aircraft Force Mixes for Contingency Deployment," AFIT/GLM/ENS/01M-10. Faculty Advisor: Major Stephen M. Swartz. Sponsor: Defense Advanced Research Projects Agency. Developed a plug-in module to the Advanced Logistics Project that assists campaign planners in choosing the best force packages for deployment in a matter of hours. Force mix selection and deployment time lines can be significantly reduced while ensuring

planners of all experience levels can make consistent decisions and actions.

- Goddard, Matthew W. "Estimating Deployed Airlift and Equipment Requirements for F-16 Aircraft in Support of the Advanced Logistics Project," AFIT/GLM/ENS/01M-11. Faculty Advisor: Major Stephen M. Swartz. Sponsor: Defense Advanced Research Projects Agency. Supports the development of the Mission-Resource Value Assessment Tool through the development of an airlift estimation function and by defining and justifying equipment requirements rule-sets, allowing the selection of optimal force packages, taking into consideration both weapon system capability and required logistics support packages.
- Hester, Ian R. "Analysis of the Effect of Centralizing Management of Mobility Readiness Spares Package Assets [MRSP]," AFIT/GLM/ENS/01M-12. Faculty Advisor: Major Marvin A. Arostegui. Sponsor: Air Force Directorate of Supply. Examined, through the Aircraft Sustainability Model, the effect of centralizing MRSP management. Results showed conclusively that the size and cost of MRSPs could be reduced without reducing aircraft availability. Cost savings for the F-15C were 25 percent, 27 percent for the C-17A, and 31 percent for the B52H.
- Hunn, Heather M. "Factors Influencing the Air Force Cycle-Ergometry Fitness Assessment," AFIT/GLM/ENV/01M-02. Faculty Advisor: Major Peter T. LaPuma. Sponsor: 311th Human Systems Wing USAF Fitness Program Office. Identified and evaluated several factors that influence Air Force cycle-ergometry fitness assessment results to potentially improve the predictive reliability of the Air Force fitness assessment program.
- Ketchum, Janette D. "Evaluation of the Air Force's Alternative Fuel Program in Complying with Executive Order 13149," AFIT/GLM/ENS/01M-13. Faculty Advisor: Dr William A. Cunningham III. Sponsor: None. Resulted in recommendations regarding the Air Force alternative fuel vehicle program to meet Executive Order 13149 requirements regarding reductions in petroleum consumption.
- Lavadour, Justin W. "Pitfalls of the A-76 Process," AFIT/GLM/ENS/01M-14. Faculty Advisor: Dr William A. Cunningham III. Sponsor: None. Evaluated the Air Force A-76 process, resulting in recommendations to the process to result in higher savings. Additionally, an evaluation of the political factors indicated that the military has neither the proper environment nor incentive structure to produce the expected savings from outsourcing with the current program.
- MacKenna, James A. "Requirements-Based Methodology for Determining AGE Inventory Levels," AFIT/GLM/ENS/01M-15. Faculty Advisor: Lieutenant Colonel Raymond R. Hill, Jr. Sponsors: Air Mobility Command Equipment Maintenance Branch and Air Force Research Laboratory Deployment and Sustainment Division. Utilized a discrete event simulation to determine desired aerospace ground equipment (AGE) inventory levels through an analysis of aircraft launches and wait time for AGE support, resulting in a defined approach for determining optimal AGE levels and cost savings.
- Martinez, Steven L. "The Effect of Improving the Logistics Pipeline on Supply Support of Aerospace Expeditionary Forces," AFIT/GLM/ENS/01M-16. Faculty Advisor: Major Marvin A. Arostegui. Sponsor: Air Force Directorate of Supply. Investigated the effect of improving the logistics pipeline on the size and cost of MRSPs through the ASM, resulting in significant savings in both requirements and spares costs. In addition, evidence to support the concept of *pipeline on the fly* was presented.
- Masciulli, Jason L. "A Cost Comparison between Modes in the Shipment of Mission Capable Parts Within the Continental United States," AFIT/GLM/ENS/01M-17. Faculty Advisor: Dr. William A. Cunningham, III. Sponsor: None. Investigated utilization of an alternative transport mode (LTL trucking) in shipping MICAPs (mission capability) within the continental United States. Currently, these are shipped exclusively via air. However, utilization of the more cost-efficient mode in every circumstance would result in an 11 percent cost savings, implying the current modal choice is less than optimal.
- Oliver, Steven A. "Forecasting Readiness: Using Regression to Predict the Mission Capability of Air Force F-16 Fighter Aircraft," AFIT/GLM/ENS/01M-18. Faculty Advisor: Lieutenant Colonel Alan W. Johnson. Sponsor: Air Force Directorate of Maintenance. Developed an explanatory forecasting model that examined how changes in five key areas will impact mission capability of F-16 aircraft. Model is robust enough to allow analysis with other airframes to determine the optimal mix of personnel, reliability and maintainability, aircraft and logistics operations, and funding and environment.
- Sanches, Paulo J. "Determining an Optimal Reparable Supply Kit for Deployment of a Tactical Radar System," AFIT/GLM/ENS/01M-19. Faculty Advisor: Major Stephen M. Swartz. Sponsor: Fuerza Aeronautica Brasilia. Developed a new deployable reparable supply kit for the Brazilian Air Force mobile radar system that results in significant economies in logistics costs and mission success using the metric optimization tool.
- Sandoval, Robert D. "An Analysis of Reliability Improvement Costs During the Engineering and Development Phase of Fighter Aircraft," AFIT/GLM/ENS/01M-20. Faculty Advisor: Lieutenant Colonel Alan W. Johnson. Sponsor: None. Developed cost-estimating relationships that estimate reliability improvement costs during the development phase of fighter aircraft, allowing tradeoff program decisions for investments in reliability to be more precise and target those activities that will achieve maximum effect.
- Sen, Yigit. "The Assessment of Program Managers' Perceptions of Importance of Stability to Overall Project Outcomes," AFIT/GLM/ENS/01M-21. Faculty Advisor: Major Stephen M. Swartz. Sponsor: None. Investigated the measures of cost, schedule, performance, earned value, and stability in terms of importance and usefulness to managers in Air Force weapons systems and result on overall project outcomes.
- Simms, Christian G. "JP-8+100LT: A Low-Cost Replacement of JPTS as the Primary Fuel for the U-2 Aircraft?" AFIT/GLM/ENS/01M-22. Faculty Advisor: Major Marvin A. Arostegui. Sponsor: Air Force Research Laboratory Propulsion Directorate Fuels Branch. Compared the use of JPTS versus JP-8+100LT fuel for the U-2 aircraft in terms of logistics benefits and costs. Concluded that JP-8+100LT was superior in terms of both logistical benefits and annual costs.
- Tuttle, Robert E. "Air Mobility Command Passenger Reservation Center System Analysis," AFIT/GLM/ENS/01M-23. Faculty Advisor: Dr William A. Cunningham III. Sponsor: Air Mobility Command Passenger Reservation Management Branch. Analyzed the AMC Passenger Reservation Center's (PRC) system-wide operating metrics and benchmarked the PRC against major airlines, showing that improved efficiency and productivity, as well as significant monetary savings, could be achieved by closing the PRC at Hickam AFB.
- Wakefield, David J. "Identification of Preferred Operational Plan Force Mixes Using a Multiobjective Methodology to Optimize Resource Suitability and Lift Cost," AFIT/GLM/ENS/01M-24. Faculty Advisor: Lieutenant Colonel Alan W. Johnson. Sponsor: Defense Advanced Research Projects Agency. Developed a quantitative solution to the identification of force mixes that represent the best tradeoff between value to task and transportation resource consumption, allowing the planner to make comparisons using different operating parameter settings and time complexity in relation to problem scale to rapidly determine the optimal force mix.
- Wasik, Robert A. "A Method for FMS Countries to Maximize CLSSA Service Levels While Minimizing Costs Through Optimal Requisitioning Patterns," AFIT/GLM/ENS/01M-25. Faculty Advisor: Major Marvin A. Arostegui. Sponsor: Air Force Security Assistance Center. Developed a model to determine an ideal ordering pattern that will provide Cooperative Logistics Supply Support Arrangement participants with the best requisition service levels while minimizing the amount of investment charge for different ordering patterns, demand levels, and item lead times.

LANTIRN Intermediate Maintenance Concepts: Other Thoughts

First Lieutenant Damon T. Farnsley, ANG

This is article is in response "EAF Challenges: LANTIRN Intermediate Maintenance Concepts" published in the *Air Force Journal of Logistics, Volume* XXIV, Number 1. The authors of the article analyzed the various options the Air Force has in supporting the low-altitude navigation and targeting infrared for night (LANTIRN) precision-guided munitions (PGM) requirements over the remaining 15-year life expectancy of the program and concluded that a centralized repair system utilizing forward support locations (FSL) was the best option. This author agrees, in part, but would like to propose an addendum to the FSL option. The addendum is about a success story. It is about ensuring warfighters are provided what they need, when they need it, and in the most efficient manner.

The Story

The 132d Fighter Wing (Des Moines, Iowa), 138th Fighter Wing (Tulsa, Oklahoma), and the 180th Fighter Wing (Toledo, Ohio) completed their conversions from the A-7 to the Block 42 (Pratt & Whitney) F-16C in late 1994. We went from an airframe with a combat mission demand of *zero* to an airframe labeled a *training asset*. As the Combat Air Force's (CAF) only Block 42 combat-coded units, we immediately struggled to find our niche in the overall Air Force combat mission.

At the time of the unit conversions, hints of the current expeditionary aerospace force (EAF)/aerospace expeditionary force (AEF) structure, global commitments, high operating tempos, and limited budgets and resources could be seen on the horizon, the unprecedented total force integration we now enjoy was *in the air*, and we *wanted in the game*.

In late 1996, as a precursor to the accepted practices in today's EAF, the 132d, 138th, and 180th combined in one of the first *Rainbow* deployments in support of Operation Provide Comfort. The *Rainbow* concept allows units to mobilize, generate, and deploy essentially as one fighter squadron to cover a 90-day commitment, keeping the personnel tempo at the level required in the peacetime Air National Guard (ANG). *Rainbowing* is now the norm for Reserve forces in support of the AEF and creates unprecedented working relationships between the involved units.

However, to be truly effective contributors to the Air Force mission with our *training assets*, we knew the answer for the three Block 42 units was the PGM mission.

We, in the Air National Guard, are proud of our history, our heritage, and especially, our capabilities. Many of those capabilities are derived from a highly experienced force where doing *more with less* is standard operating procedure. Speaking personally, I am continually awed by the corporate knowledge, mission dedication, and the plain old *know-how* of these community-oriented guardsmen. As an example, the 138th has a maintenance squadron supporting 15 primary asssigned aircraft, where its *members' average* years of experience is a few days shy of 12.5 years. This is counting everyone, from a young traditional guardsman recruit awaiting a basic military training date to a shop chief who has been turning wrenches full time in an Air Force uniform since 1965. These professionals know their jobs, and believe me, they know them *very* well. What do these facts have to do with a new maintenance concept? The answer lies in the dynamics of a team of professionals facing a challenge and being able to come up with a solution that works.

The Challenge

Prior to 1997, the only F-16 LANTIRN units in the active and Reserve CAF were in the Block 40 (GE). The issue being the Pratt & Whitney equipped Block 42s lacked the power to perform the full LANTIRN mission. The full mission included both the navigation pod, which provides forward-looking infrared and automatic terrain following, and the laser targeting pod (TGP), which provides all of the PGM capabilities. Indeed, with one or both pods hanging on a Block 42, the aircraft performance was degraded below the low-altitude operational requirements. The aircraft could handle one pod and meet performance requirements at medium altitude so the term MANTIRN was coined. These training assets found their niche—medium-altitude PGM. The Block 42s contained the software and hardware capability to carry and employ TGPs with zero modifications, so it made sense to equip them to help reduce the active component's PGM operating tempo. The PGM mission can be accomplished by using only the TGP.

The three wings completed their LANTIRN (TGP only) site activation task force (SATAF) and received the initial assets in March 1997.

LANTIRN TGPs and support equipment are very limited in number. The CAF has at its disposal only so many pods and only so much support equipment, and the demand is high. The Air Force's original support concept for the LANTIRN system was designed to provide for nine operational bases. However, at the time of the SATAF, 17 sites required support, creating a severe shortage of assets. Therein lies the challenge. When it was all said and done, the three wings (total of 45 primary mission aircraft inventory [PMAI]) were tasked with the training and currency of more than 90 pilots, flying 51 possessed aircraft, in three geographically separated locations, with a handful of TGPs (it was not until February 2000 during our third *Rainbow* Operation Northern Watch deployment tasking in the PGM role that we received the last of our 18 allotted TGPs).

Support Equipment

In the process, it was determined the 138th would provide the TGP repair capability and serve as the *Queen Bee*, for lack of a better term, for the Block 42 coalition. The LANTIRN mobile shelter set (LMSS) is what the Air Force uses for intermediate-level support equipment. Like the pods themselves, The shelter sets are limited in number; it took 20 months from receipt of the initial eight pods until an LMSS could be set up in Tulsa. In the interim, a solution had to be found. Initially, the 150th at Albuquerque, the only other LANTIRN-equipped ANG unit, and Sheppard AFB, Texas, provided TGP maintenance support for the coalition. Unserviceable pods were either ferried by aircraft for the 150th or the Sheppard AFB schoolhouse to repair, or 138th sensor technicians would accompany pods over the road to provide personnel support. This was a cumbersome process, to say the least.

In November 1997, the Navy made available one of their DATE II test units, allowing Tulsa to borrow it on a temporary basis, providing pod repair capability at home station. The DATE II, designed for use on aircraft carriers, consists of the test rack and a BRITE (Battle-Ready Integrated Test Equipment) equipped electro-optical test set bench (an upgraded version of the Air Force electro-optical test set used in the LMSS). The unit allows for optical alignment and recertification of TGPs in a *significantly* smaller package. The coalition sensor technicians were so impressed by the capabilities of the DATE II that they pursued the idea of using a similar tester with certain modifications to enhance the suitability for the ANG mission.

In January 1998, the ACC Directorate of Maintenance and Logistics directed the transfer of an LMSS to the 138th from the 388th Fighter Wing, Hill AFB. This almost came as a surprise as the coalition had all but given up on the possibility of owning an LMSS, but it did not slow down the pursuit of a DATE II-type tester. The idea of a small footprint, upgraded capabilities, and greater reliability was the prime motivator.

Lockheed Martin Information Systems was eventually awarded a contract to provide a modified DATE II tester. The modifications included software upgrades; backwards compatibility with the Air Force LMSS; the addition of an aircraft simulator function; and for it to be modular with transit cases, greatly enhancing the deployability. Informally dubbed the ANG LANTIRN equipment (ANGLE), the capabilities quickly captured the attention of ACC LANTIRN program managers.

Working with the ACC LANTIRN Directorate, Lockheed Martin in Orlando, and Warner Robins Air Logistics Center LANTIRN Office, as well as the ANG Readiness Center, the specifications were given, the Navy DATE II was returned with many thanks, and Tulsa began validating the new prototype's capabilities in May 1998. When ACC decided it was something it wanted to pursue in its midlife upgrade of the LMSS, the more generic and official term of ADK (advanced deployment kit) was given to the tester.

Thus the ADK was born. The advantages of an ADK are many:

- The entire package can be deployed on one 463L pallet and one MHU110 trailer, meeting the small footprint goals of the AEF.
- Setup time is minimal. In less than 2 hours from arriving at a deployed location, the ADK can be up and running.
- Enhanced operational testing and pod certification allows much higher throughput than an LMSS.
- It is fully functional on both Air Force and Navy LANTIRN TGP assets.
- The aircraft simulator function allows technicians to run and operationally check a TGP as if it were aircraft mounted.
- Contains full TGP-troubleshooting capabilities.

While it does not have the capability to repair line-replacement units, as in the LMSS, a deployed ADK with an mission ready spares kit provides a quick and effective in-theater repair capability. The ADK performed flawlessly during two 90-day *Rainbow* deployments to Operation Northern Watch. The theater commander enjoyed an unprecedented 100 percent TGP availability rate for the duration of both periods.

The Managing Partner Concept

Referring back to the challenge the Block 42 coalition faced in standing up the PGM mission, the three units quickly realized the standard *Queen Bee* form of maintenance support would not work. While all other LANTIRN units throughout the Air Force enjoyed owning a pod for each PMAI, we possess 18 pods for a 45 PMAI. Being nowhere near a fully equipped LANTIRN unit, the coalition had to come up with a system providing equitable distribution of fully mission capable (FMC) TGPs to the three units for upgrade, recurrency training, and contingency spin-up.

A theory devised by the coalition leadership was put into practice: the Managing Partner Maintenance Concept. The 138th acts as the managing partner, while the 132d and 180th are general partners. The key element is that all assets are owned by the coalition itself, not any one partner. The managing partner retains the associated support equipment, readiness spares package, and repair capabilities and is responsible for all back-shop maintenance and FMC pod distribution according to unit needs. This form of support and repair, with rights to assets but without specific asset ownership, spreads a finite number of assets across a greater number of tasked units.

The goal of the managing partner, beyond maintaining the highest FMC rate possible, is parity in the distribution of TGPs among itself and its general partners. Each of the wing's standing requirements for training and temporary duties is filled and maintained objectively to preserve parity among the partnership. This requires all the partners to maintain a system of free-flowing communication between the wing's operations and maintenance functions, providing continuous TGP status and unit requirements visibility.

The concept has worked very well within this coalition. These units had already created new paths of cooperation in *Rainbow* operations; the managing partner concept was an unproblematic progression. In short, this form of centralized support and repair has allowed the three units to ramp up and maintain PGM-mission capability with one-third the assets normally used. A big bonus for our particular program is the addition of the ADK. The ADK, along with the LMSS at home station, allows a *light, lean, and lethal* deployment of TGP repair capability with one of the partner units while retaining home-station repair capability for the remaining nondeployed unit's currency and spin-up training.

The managing partner concept is not radical in its basic tenants; it isn't a brave new world of logistics management. It is just a different way to cope with the *more with less* reality, with inter-unit cooperation being at its core. The potential exists for this kind of thinking to move beyond the ANG Block-42 Coalition LANTIRN program. With today's operating tempo.

Lieutenant Farnsley is with the 138th Fighter Wing, Oklahoma Air National Guard.

(Maintenance Support Strategies continued from page 19)

making involving all stake-holders; an overriding emphasis on operational output; and most important, a high level of trust between all the parties. These changes may well result in smaller organic military repair facilities and the greater use of contractors at all maintenance levels, including overseas. Most important, it will require the military aviation maintenance organization to move away from an internal focus on efficiency and utilization to a holistic approach that puts customer needs, in the form of operational output, first and foremost.

As the SDR concluded, "The military effectiveness of modern armed forces depends more than ever on the quality of their logistic and other support arrangements, where necessary adopting modern methods and best practice."[12]

Notes

1. *The Strategic Defence Review—Supporting Essays*, Stationary Office, London, 1998.
2. The Lean Aircraft Initiative, sponsored by the USAF, seeks to half cycle times and costs of future weapons systems while greatly improving performance. AW&ST, 3 Jun 96 and 28 Jul 97.
3. Lt Gen William P Hallin, "The Challenge of Sustaining Older Aircraft," *Air Force Journal of Logistics*, Vol XXII, Summer 1998, 1-2.
4. NATO Report, *Modifying Defence Equipment*, Stationary Office, 1998.
5. It should be noted that these figures represent operating costs and not budgetary responsibilities.
6. The USAF Lean Logistics initiative has successfully applied similar techniques to reduce component turn-round times, notably in the avionic and propulsion areas.
7. The Supply Excellence Programme (SEP), which has been developed from a variety of quality management models and industry standards (such as the Baldridge and European Foundation for Quality Management Models), seeks to enhance the business performance of BAE Systems' supplier base through the employment of a business excellence-based assessment, statistical process control, and improvement tools and techniques. Some 75 percent of suppliers, by bought-out value, participate in the SEP.
8. Two-Level Maintenance (TLM) and the associated Lean Logistics initiative have reduced the average repair cycle times for typical avionics line replaceable units from 17 to 9 days. *Overhaul & Maintenance*, Jan 97, 55-57. The application of TLM principles and associated efforts have reduced the outload requirement to support a squadron of F-22 aircraft by two-thirds compared to the F-15, "Unlikely Partners: Two-Level Logistics and the Air Force Gold Programme," *Air Force Journal of Logistics*, Vol XX, Spring 1996, 1-4.
9. This compares, however, to the 90 percent performed in house in the 1970s, *AW&ST*, 30 Aug 99.
10. Col S. J. Zamparelli, "Contractors on the Battlefield," *Air Force Journal of Logistics*, Vol XXIII, Fall 1999, 8-17.
11. *AW&ST*, 13 Sep 99, 75-82.
12. SDR Defence White Paper, 1998, 209.

Air Commodore Dye is assigned to the RAF Maintenance Group Defence Agency at St Athan Barry, United Kingdom. He is a frequent contributor to the Air force Journal of Logistics.

(Expeditionary Airpower continued from page 31)

20. Hallin, 1-3.
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22. Lt Gen John J. Cusick, USA, et al, "Focused Logistics: A Strategic Perspective," Panel 1, 52d Annual National Defense Transportation Association Transportation and Logistics Forum and Exposition, *Defense Transportation Journal*, Vol 53, No 6, Dec 97, 20-29.
23. *Ibid*.
24. Wilhelm, 38.
25. Lt Col Brad Lafferty, "Strategic Alignment," lecture, Air Command and Staff College, Maxwell AFB, Alabama, 25 Aug 99.
26. *Ibid*.
27. Steven W. Semler, *Exploring Alignment: A Comparative Case Study of Alignment in Two Organizations*, 30-1, Honeywell International/University of Minnesota, Organizational Alignment Conference, Mar 00.
28. Quoted in Lafferty lecture.
29. Robert S. Tripp, et al, *Enhancing the Effectiveness of Expeditionary Aerospace Forces Through Integrated Agile Combat Support Planning*, RAND Report DRR–1857-AF, Santa Monica, California: RAND, May 99, 7.
30. Gen John P. Jumper, "Operating Abroad," *Air Force Magazine*, Vol 81, No 12, Dec 98, 28-29.
31. Grp Capt Peter J. Dye, RAF, "Logistics Lessons from the Past—Deployed Operations," *Air Force Journal of Logistics*, Vol XX, No 3&4, Summer-Fall 1996, 31.
32. Jumper, 29.
33. Detail Concept Paper—Expeditionary Aerospace Force, Aerospace Operations 538 Impact of the AEF on Theater Operations, Air Command and Staff College, Maxwell AFB, Alabama, Feb 00, 12.
34. Maj Gen Michael Zettler, "Agile Logistics," *Exceptional Release*, Fall 1998.
35. Author's interview with Lt Col Michelle Smith, Chief, Logistics Officer Assignments Branch, Air Force Personnel Center, 27 Dec 99.
36. Author's interview with Capt Anne Pryze, Provisional Air Base Group, Director of Logistics, Tuzla AB, Bosnia, 23 Apr 99.
37. Glen W. Goodman, Jr, "An Expeditionary Aerospace Force: USAF Plans a Fundamental Shift in How It Responds to Global Contingencies," *Armed Forces Journal International*, Vol 136, No 1, Aug 98, 18-19.
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39. *Ibid*.
40. Personal e-mail and survey, Capt Malcom Blair, A-4, 31, AEW, Operational Allied Force, Aviano AB, Italy, 3 Jun 99 and 8 February 00.
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46. *Ibid*.
47. Steven Lange, "The Imperial Japanese Navy Air Force in the Pacific War," np, [Online] Available: http://www.skypoint.com/~jpp/ijnaf.htm, 13 Mar 00.
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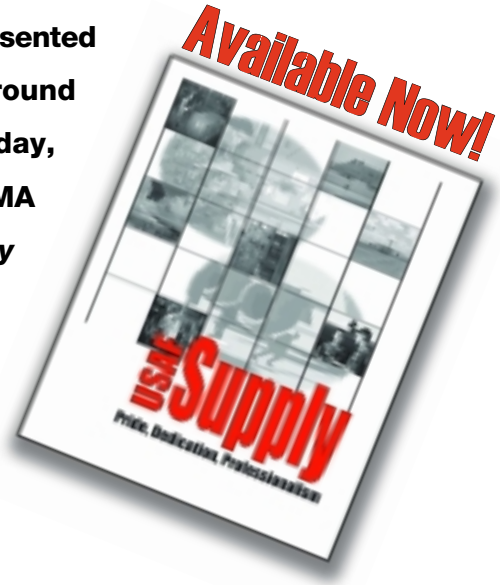

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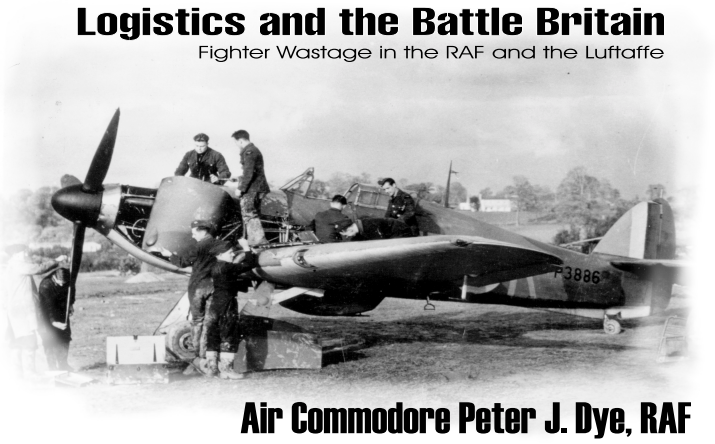
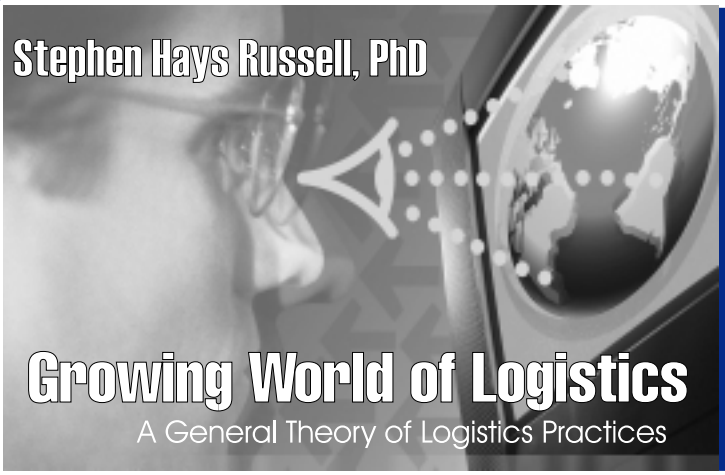


The Editorial Advisory Board selected "Logistics and the Battle of Britain: fighter Wastage in the RAF and the Luftwaffe"—written by Air Commodore Peter J. Dye, RAF—as the most significant article to appear in the *Air Force Journal of Logistics*, Volume XXIV, Number 4.



The Editorial Advisory Board also selected "Growing World of Logistics: A General Theory of Logistics Practices"—written by Stephen Hays Russell—as the most significant article to appear in the *Air Force Journal of Logistics*, Volume XXIV, Number 4.