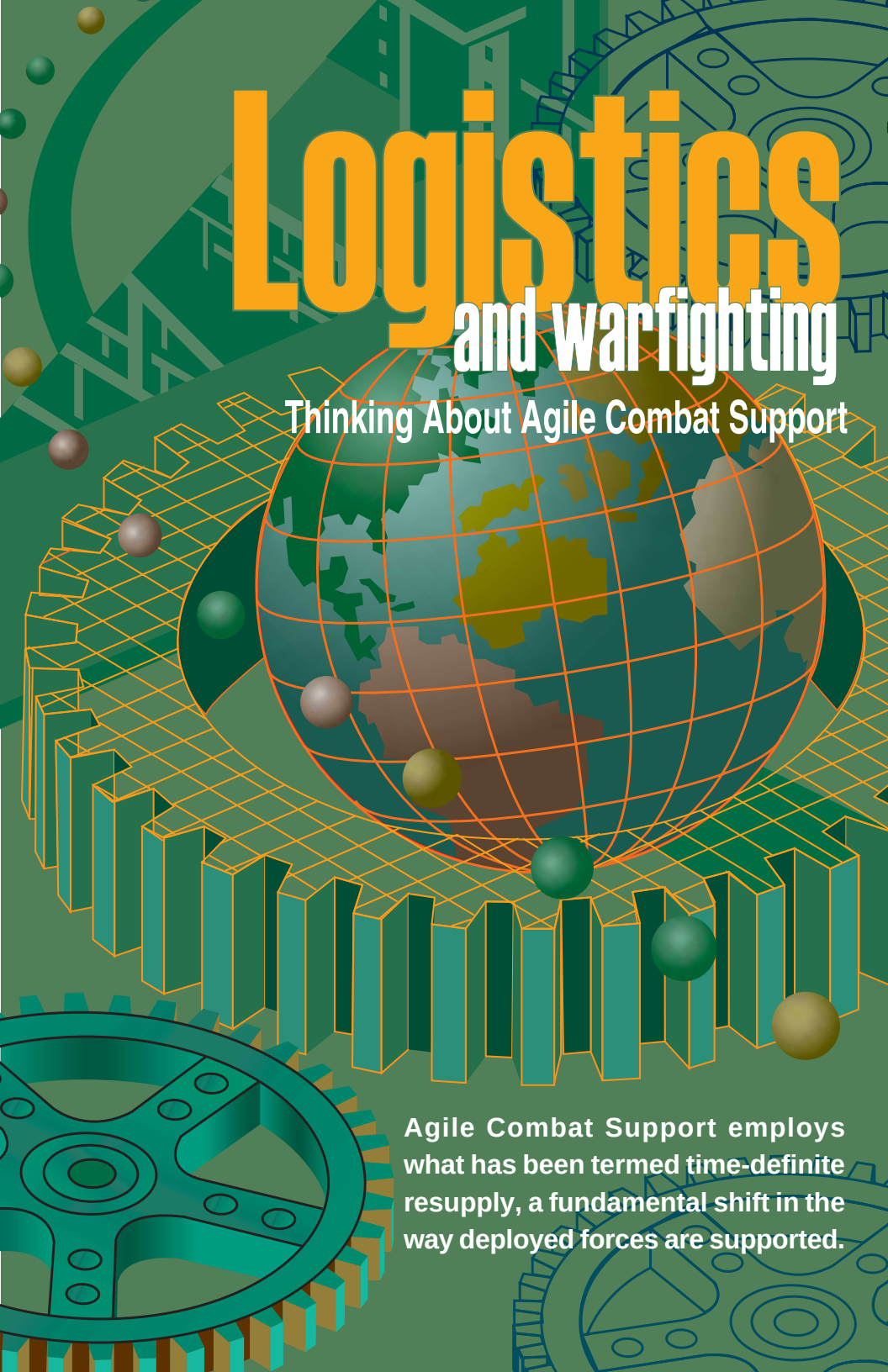
Logistics and warfighting

Thinking About Agile Combat Support



Agile Combat Support employs what has been termed time-definite resupply, a fundamental shift in the way deployed forces are supported.

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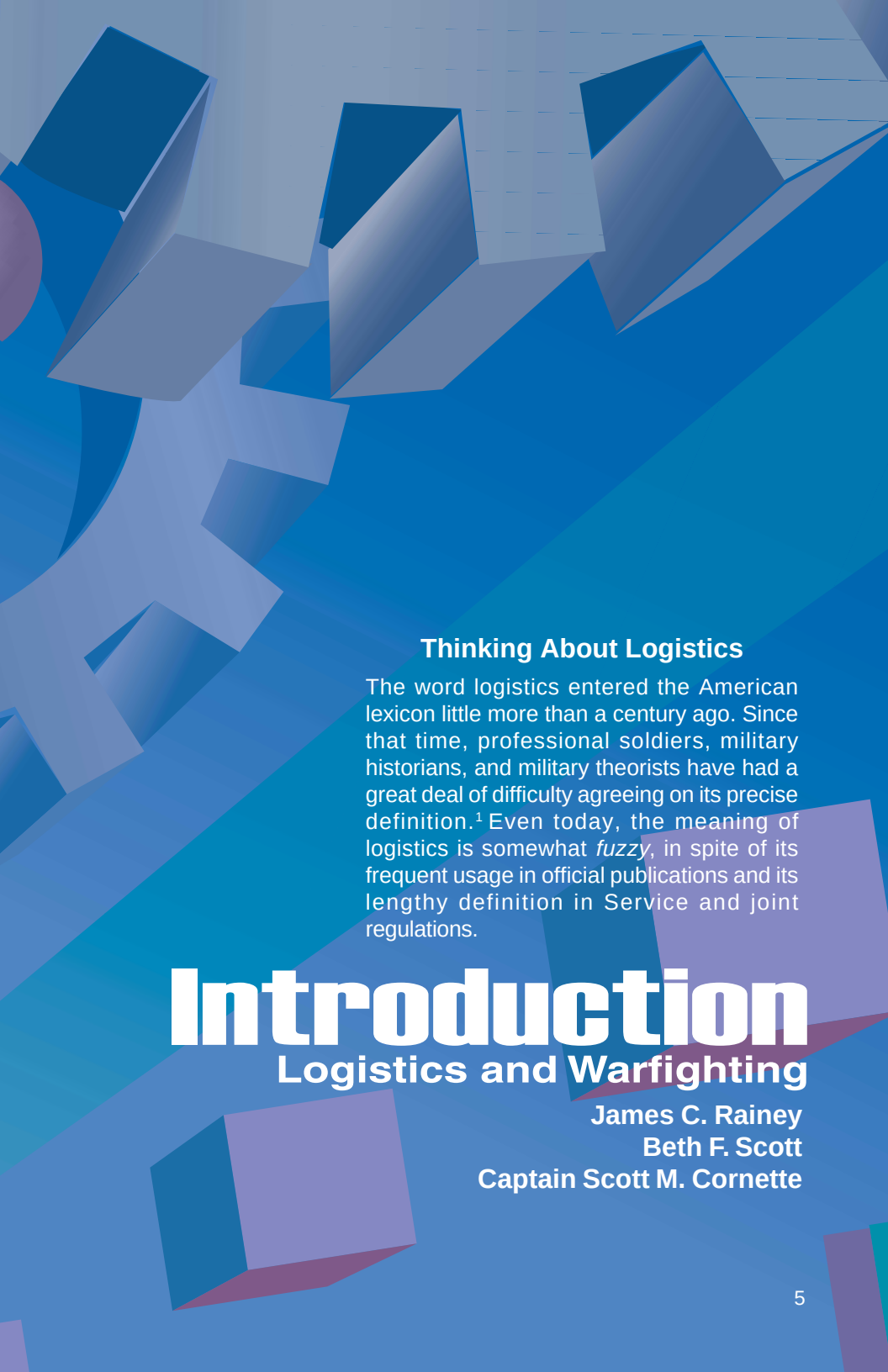

Thinking About Logistics

The word logistics entered the American lexicon little more than a century ago. Since that time, professional soldiers, military historians, and military theorists have had a great deal of difficulty agreeing on its precise definition.[1] Even today, the meaning of logistics is somewhat *fuzzy*, in spite of its frequent usage in official publications and its lengthy definition in Service and joint regulations.

Introduction

Logistics and Warfighting

James C. Rainey
Beth F. Scott
Captain Scott M. Cornette

Introduction

Modern warfare demands huge quantities of fuel, ammunition, food, clothing, and equipment.

The eminent historian Stanley Falk defines logistics on two levels. First, at the immediate level:

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

Second, at a higher level, logistics is the:

> …economics of warfare, including industrial mobilization, research and development, funding procurement, recruitment and training, testing and, in effect, practically everything related to military activities besides strategy and tactics.[2]

In 1904 Secretary of War Elihu Root warned that "our trouble never will be in raising soldiers: our trouble will always be the limit of possibility in transporting, clothing, arming, feeding and caring for our soldiers . . . ."[3] Logistics has, in fact, proven to be a key element in 20th and 21st century warfare; however, it also has been an element often not adequately documented or understood. Military professionals, historians and theorists have been all too susceptible to the view that relegates logistics to the background of their work. A recurring theme has been the tendency for both the political and military leadership to neglect logistical activities in peacetime and to expand and improve them hastily once conflict has broken out. This may not be as possible in the future as it has been in the past. A declining industrial base, flat or declining defense budgets, force drawdowns, and base closures have contributed to eliminating or restricting the infrastructure that made rapid expansion possible. The real impact of Competitive Sourcing and Privatization (formerly Outsourcing and Privatization) on force projection and logistics support is still a matter of conjecture and debate. Regardless, modern warfare demands huge quantities of fuel, ammunition, food, clothing, and equipment. All these must be produced, purchased, transported, and distributed to military forces—and, of course, the means to do this must be sustained. Arguably, logistics in the 21st century will remain, in the words or one irreverent Word War II

supply officer, "the stuff that if you don't have enough of, the war will not be won as soon as."[4]

Thinking About Warfighting and Logistics

The end of the Cold War and experience gained from the conflicts in Grenada, Panama, and the Persian Gulf essentially brought the era of *brute force* logistics to a close. The traditional practice of using massive quantities of troops and large stockpiles of supplies available in theater to engage sizable hostile forces is obsolete. Additionally, extensive buildup time and lengthy resupply and repair pipelines to sustain forces are unrealistic. The focus of logistics has now shifted toward rapid movement of small, independent force packages to employ precise combat power anywhere in the world. This revolutionary change has many influences. The rapid change in political dynamics of the world powers, domestic fiscal constraints, and technological advances have rendered the Cold War military strategy and preparation ill-equipped to handle 21st century missions, requirements, and demands.

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The US role in the post-Cold War world has changed dramatically. Military forces are no longer dedicated solely to deterring aggression but must respond to and support homeland defense and humanitarian missions. From peacekeeping to feeding starving nations, to conducting counterdrug operations, the military continues to adapt to evolving missions. Logistics infrastructure and processes must continuously evolve to support the new spectrum of demands. The keys to successfully supporting combat operations are robust, responsive, and flexible logistics systems.

Decreases in funding and the drawdown of the US military in the 1990s drove new approaches to logistics support and refinement of the military logistics systems. These fiscal constraints dictated that the military must reduce infrastructure, maintain smaller numbers of both inventory and personnel, and find ways to reduce costs without degrading mission capability.

Reduced budgets impact weapons modernization programs in several. As dollars decrease, fewer systems can

be developed, which increases the importance of decisions made in the acquisition process. The process must develop the most lethal systems while emphasizing reliability and supportability. Therefore, logistics considerations play a more important role than ever in the design, production, and fielding of new systems. Logistics capabilities for supporting future forces require systems to be *smarter* and require less maintenance.

Information technology will improve the ability to see, prioritize, and assess information.

Technology not only affects the development and sustainment of weapons systems but also offers the opportunity to modernize and improve the information infrastructure. This will facilitate joint operations, provide timely access to data and enable electronic interface to the commercial sector. Information technology will improve the ability to see, prioritize, and assess information. Improved intelligence gathering and intransit visibility are just two of the capabilities that must be maximized in the development and enhancement of information systems. The integration of information systems will allow for real-time visibility of data, enabling decisionmakers to act on current, accurate information. The logistics community must examine existing processes through a variety of studies and analyses and look for ways to make quantitative and qualitative improvements. Accepted theories, practices, and processes need to be examined and, where necessary, challenged and changed. Combat operations in the 21st century will require highly responsive and agile forces.

Focused Logistics and Agile Combat Support

Two logistics concepts dominate Air Force logistics today: Focused Logistics at the joint level and Agile Combat Support within the Air Force. The vision of both these concepts is the ability to fuse information, transportation, and other logistics technologies to provide rapid response, track and shift assets while en route, and deliver tailored logistics packages at all levels of operations or war. This same vision includes enhanced transportation, mobility, and pinpoint delivery systems. Air Force logistics will also change as a result of a variety of initiatives—for example,

Chief's Logistics Review, Combat Wing Organization, Spares Campaign, and changes to depot maintenance.

Logistics and Warfighting

Logistics and Warfighting is a collection of essays, articles, and studies that lets the reader look broadly at many of the issues associated with Agile Combat Support. The content was selected to both represent the diversity of the challenges faced and stimulate discussion about these challenges. Also included is a short history of transporting munitions.

Additional copies of *Logistics and Warfighting* are available at the Office of the Air Force Journal of Logistics.

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Notes

1. George C. Thorpe, *Pure Logistics*, Washington DC: National Defense University Press, 1987, xi.
2. Alan Gropman, ed, *The Big L: American Logistics in World War II*, Washington, DC: National Defense University Press, 1997, xiii.
3. Charles R. Shrader, *U. S. Military Logistics, 1607-1991 A Research Guide*, New York: Greenwood Press, 1992, 9.
4. Julian Thompson, *The Lifeblood of War: Logistics in Armed Conflict*, Oxford: Brassy's, 1991, 3.

We move on time lines that simply will not work if we have to wait for support for our expeditionary forces.

—General Ronald R. Fogleman

Agile Combat Support
A Brief Discussion

James C. Rainey
Beth F. Scott
Captain Scott M. Cornette

What is Agile Combat Support

The development and refinement of expeditionary airpower (expeditionary aerospace forces) required rethinking many Air Force logistics functions and concepts—principally the combat support functions. Expeditionary airpower required making the Air Force support systems far more agile than they previously had been. Recognizing this, the Air Force began transforming its support systems into the Agile Combat Support (ACS) system. ACS is the central support concept that ensures both the viable of expeditionary airpower and the ability to support joint force requirements. It improves the responsiveness, deployability, and sustainability of forces, and it substitutes responsiveness for the massive inventories of the past.

Time-Definite Resupply

Since the early 1990s, the Air Force has been developing and refining the practices and processes supporting Agile Combat Support and the joint logistics concept—Focused Logistics. Clearly, military operations in the 21st century must have responsive and agile operational and support forces. To achieve this, Agile Combat Support employs what has been termed time-definite resupply, a fundamental shift in the way deployed forces are supported. With time-definite resupply, the mobility footprint of early arriving

forces is reduced, and resupply of deployed forces begins upon their arrival, thus reducing initial lift requirements. This not only optimizes available lift and reduces costs but also makes it possible to reduce the size and, therefore, the vulnerability of forces.

Reachback

Historically, logistics systems pushed *support to deployed forces to compensate for less-than-perfect resource information and planning systems.*

Historically, logistics systems *pushed* support to deployed forces to compensate for less-than-perfect resource information and planning systems. This often resulted in an expensive and wasteful stockpile of materiel in US warehouses and forward locations. This approach to globally prestocking large quantities of materiel is not viable in the 21st century—operationally or politically. Under the ACS concept, high-velocity, reliability transportation and information systems are used to get the right parts to the right place, at the right time. When a part is required, the system will *reach back* and *pull* only those resources required. Time-definite delivery forms the basis for all resupply in the theater of operations, thereby reducing total lift requirements. This reachback approach makes it possible to deploy fewer functions and personnel forward for deployment and sustainment processes. This, in turn, reduces the size and, therefore, the vulnerability of forward deployed forces.

Streamlined Depot Processes

Under ACS, streamlined depot processes will release materiel in a more timely fashion than in the past. Rapid, time-definite transportation will complete the ACS support process by delivering needed materiel directly to the user in the field. Integrated information systems will provide asset visibility throughout this process, tracking items throughout the order and delivery cycle with the capability to redirect them as the situation dictates.

There are still many issues associated with ACS that require resolution. A variety of studies have been completed or are ongoing to examine these issues. RAND and the Air Force Logistics Management Agency have played a principal role in the ACS studies and analysis process.

Thinking About Logistics

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

General Mathew B. Ridgeway once observed, "What throws you in combat is rarely the fact that your tactical scheme was wrong…but that you failed to think through the hard cold facts of logistics." Logistics is the key element in warfare, more so in the 21st century than ever before. Success on the modern battlefield is dictated by how well the commander manages available logistical support. Victories by the United States in three major wars (and several minor wars or conflicts) since the turn of the century are more directly linked to the ability to mobilize and bring to bear economic and industrial power than any level of strategic or tactical design. The Gulf War and operations to liberate Iraq further illustrates this point.

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

Unfortunately, the historical tendency the political and military leadership to neglect logistics activities in peacetime and expand and improve them hastily once conflict has broken out may not be so possible in the future as it has in the past. A declining industrial base, flat or declining defense budgets, force drawdowns, and base closures have all contributed to eliminating or restricting the infrastructure that made rapid expansion possible. Regardless, modern warfare demands huge quantities of fuel, ammunition, food, clothing, and equipment. All these commodities must be produced, purchased, transported, and distributed to military forces. And of course, the means to do this must be sustained. Arguably, logistics of the 21st century will remain, in the words of one irreverent World War II supply officer, "The stuff that if you don't have enough of, the war will not be won as soon as."[43]

Notes

1. John A. Lynn, ed, *Feeding Mars: Logistics in Western Warfare from the Middle Ages to the Present*, San Francisco: Westview Press, 1993, vii.
2. Charles R. Shrader, *U.S. Military Logistics, 1607-1991, A Research Guide*, New York: Greenwood Press, 1992, 3.
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Does the Coalition Theater Logistics, Advanced Concept Demonstration Project Meet Multinational Logistics Data Sharing Requirements?

Part Grouping

Angioplasty for the Supply Chain

A part grouping system relates to the idea of group technology but has a slightly different approach.

Colonel Michael C. Yusi, USAF

Hey, *loggie* warfighter, your aged weapon systems are full of *tired iron*, you have diminishing manufacturing sources for mission critical spare parts, your industrial base is getting colder, and lead times are getting longer each day. Logistically, you have hardening of the arteries: no agility, no flexibility, and no options, right? Well, there is angioplasty for your supply chain. This article analyzes how a supply chain part grouping system mitigates these types of problems and reopens supply chain blood flow for improved health. It defines this system, describes how this process begins, explains how rigor is put back into a cool industrial base, demonstrates how it smooths variations in demands and decreases production lead times, and shows how it improves availability and lowers costs of critical parts for end users. Examples from the Defense Logistics Agency (DLA) are used to elaborate some points even further. Finally, results of a part grouping concept demonstration between the Boeing Company and DLA are highlighted and reviewed.

Part Grouping Definition

A part grouping system relates to the idea of group technology (GT) but has a slightly different approach. Thomas E. Potok, Collaborative Technologies Research Center, Oak Ridge National Laboratory,

Part Grouping: Angioplasty for the Supply Chain

The variety of grouping options based on common manufacturing processes includes a wide number of factors.

states manufacturers view group technology "batching parts to take advantage of economies of scale," which usually will "be produced on a single manufacturing floor."[1] A part grouping system, however, effectively leverages a supply chain by "arranging the production of individual items into groups that are based on common manufacturing processes,"[2] as well as similar part materials or vendor capabilities. In addition, it is not fixed to just one manufacturing line or vendor. Instead, it takes advantage of using different vendors with processes and capabilities that can be applied to producing a group of parts. In a macroillustration, a part grouping system includes things like processing methods, steps, lines, and production capacities needed to make a group of parts. It considers similarity of part materials (metal, rubber, and carbon-fiber) and if the parts are in some type of general *family* such as machined, structural, or sheet metal. Continuing even further, if it is machined or has structural parts using similar types of materials, it considers things such as general form, shape, gauge thickness, and number of welding points these parts have. It considers the cost to make these parts per unit of measure, such as a range between \$x.xx → \$x.xx per foot. The point here is the variety of grouping options based on common manufacturing processes considers a wide number of factors. Expressed this way, a supplier who manages a variety of parts for many customers and missions achieves supply chain leverage using a part grouping system by partnering with a broad number of manufacturers possessing a range of capabilities with links to common manufacturing processes. This ensures greater depth and breadth of parts for the supplier when needed. This is in lieu of a supplier's depending (or being victim) on a few vendors or a single vendor with fixed capability making only one part. Another real possibility for a supplier is having no vendor available at all. This kind of scenario adversely impacts the mission capability of a customer's weapon system needing a *zero-balance* 35-five cent widget, grounding a fleet of F-16 jets or M1A1 Abrams tanks. With this in mind, improved supply chain agility, flexibility, and vigor (blood flow) using a part grouping system are possible.

Beginning the Supply Chain Angioplasty Process

Starting a part grouping system is the tough part; it is like *intrusive surgery*. It involves a supplier's collecting, organizing, and sharing large amounts of information on parts it manages and customers it supports to team with interested manufacturer and vendor groups. An interested manufacturer, in turn, must take the supplier data and assess its production base to link common manufacturing processes to part characteristics to determine what supply chain improvements it can offer in a part grouping system. This is much easier said than done; however, it is needed to pave a way through the supply chain arterial system for the supplier to get the high-ratio manufacturer partnerships to achieve part grouping system payoffs. For example, the DLA (as a supplier) provides Class IX spare parts for all military services. This includes managing more than 2.6 million national stock numbers (NSN) coded to more than 1,368 aerospace, land, and maritime weapon systems for the Air Force, Navy, Army, and Marine Corps.[3] This sheer number of NSNs, along with the range of warfighter customers and weapon systems supported, as well as the large number of manufacturers currently working with the DLA, makes starting a task daunting. This startup difficulty, however, can be mitigated for supplier and manufacturer. How? Well, they can decide to narrow the initial part-grouping target based on a specific range of weapon systems or end items such as tracked armored vehicles, jet aircraft, instruments, or electrical systems. By doing so, focused leverage can be placed on certain weapon systems, which not only gets the process started but also can include the interests expressed by supply chain customers.

Certainly, a feasible startup process greatly benefits from a method or tool to help the potential manufacturer and supplier (willing to move into a part grouping arrangement) integrate necessary information. Necessary information from the supplier includes basic things such as part nomenclature, part numbers, form, fit, function applications, past and present part manufacturer, monthly, quarterly, and annual customer demands, cost to procure, and current production lead times. Necessary

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Part Grouping: Angioplasty for the Supply Chain

One prototype tool that can begin the angioplasty process is the Supplier Utilization Through Responsive Grouped Enterprises Part Grouping Tool.

information from the manufacturer includes basic things like part process characteristics (4 or 5-axis mill, turning, stamping), part family characteristics (wiring, sheet metal, tubing), producer qualifications, standard bill of materials, as well as administrative data such as production planning and quality control inspection steps.

An example of one prototype tool that can begin the angioplasty process is the Supplier Utilization Through Responsive Grouped Enterprises Part Grouping Tool. This decision support tool from DLA allows manufacturers to input indicative process data from their end and use them to bump against the indicative parts data managed by DLA into a broad range of grouped combinations consisting of simple → specialized → complex parts. Utilizing such a tool, both supplier and manufacturer can begin looking at part grouping options for consideration in a supply chain partnership. The tool can also weight part characteristics or the priority of processing stages to help manufacturers filter processing commonalities and fine tune initial group options even further.[4] Working in this manner, a variety of capabilities to facilitate the part grouping supply chain partnership are derived and ultimately begin opening the blood flow of the supply chain.

Putting Rigor Back into the Industrial Base

Edward Aldridge, Jr, Under Secretary of Defense for Acquisition, Technology, and Logistics, said, "If we are to deliver the best quality weapon systems for warfighting, then it's got to come from an industry that is competitive and innovative and healthy."[5] For a large military supplier like DLA, expanding its supply chain strategy for nearly 3 million weapon system spare parts from individual contracts to a part grouping system has potential for manufacturers (including second and third-tier business subsidiaries) to team and make a broader range of items, getting into more business markets. By doing so, these manufacturers share new markets not available for them individually, as well as profits that come with these markets. It is mutually beneficial (for the supply chain) for the manufacturers to work in a part grouping system and also benefits the supplier partner such as the DLA, in terms

of having more part sources available to support its military service customers and aging weapon systems. John A. Tirpak said, "Today, over 41percent of the USAF aircraft inventory is more than 24 years old" and also noted the B-52H is "almost 40 years old."[6] Not-mission-capable-supply cause-code *A*, first-time demands for Air Force weapon system spare parts are as high as 37-40 percent.[7] In a supply chain environment with weapon systems exceeding life-cycles and consuming more nonmarket-ready parts, a part grouping system is a *win win* for participants.

By working in a part grouping system, a small business (that may depend entirely on a defense contract) struggling with cash-flow, since it produces only a few items with low demand density, has an opportunity to broaden its production of items; increase its density of demand; and subsequently, increase its cash-flow. This makes even further sense if this low demand density company has additional production capacity that it is not able to fully optimize because of its limited business profile; therefore, risk of entering into a more dynamic part grouping system is even less compared to the potential payoffs in profits. In addition, by leveraging common manufacturing processes through multiple manufacturers, smaller businesses that have some additional and unique manufacturing capability critical to the Department of Defense (DoD) have opportunities to break into and thrive in a competitive supply chain. This is in lieu of just getting by because of their previously limited market share. Peter J. Higgins, a logistics management specialist at the Army Logistics Management College states, "As a result of fewer and smaller DoD contracts, some vital production capabilities unique to the defense industry are in jeopardy. For corporations to remain viable, their individual components must be profitable, or they will be shut down."[8] A part grouping system sweetens the business pot for a supply chain to have more diverse manufacturers, keeps special capabilities that may be unique to support aged weapon systems alive and well, provides more reliable sources of supply for the supplier, and puts vigor back into a cool industrial base.

In a supply chain environment with weapon systems exceeding life-cycles and consuming more nonmarket ready parts, a part grouping system is a win win *for participants.*

In 1999, the Pentagon chartered the Defense Science Board (DSB) to look at the health of the defense industrial

Part Grouping: Angioplasty for the Supply Chain

Hardening of the supply chain arteries can be slowed, stopped, or even reversed.

base. The DSB task force stated, "Unless action is taken soon, the US defense industry will likely be less competitive and financially viable in 5-10 years."[9] One of the recommendations from the DSB was to structure DoD programs to preserve a competitive industrial base.[10] With a $15.2B (in annual sales) supplier like DLA, cash incentives and broader opportunities, using a part grouping system, become exponential and can strategically influence and preserve the industrial base from a national perspective.[11] As a result, hardening of the supply chain arteries can be slowed, stopped, or even reversed.

Smoothing Demand Variability and Reducing Production Lead Times

Figures 1 and 2 show the difference in demand variability between parts managed individually versus by part grouping system.[12]

Why is this important? For a manufacturer, more demand variability with individually managed items (Figure 1) means more opportunity to be in an out-of-stock position if demands unexpectedly spike or if interruptions occur. This is because demand variability is tough to anticipate in a highly dynamic supply chain environment, such as exists today with aging weapon systems incurring more first time demands for spare parts exceeding life-cycles. So if a manufacturer is managing parts individually, it can attempt to mitigate demand spikes by carrying more inventory, holding reserve production capacity to meet needs as they occur, or producing parts with more shift work (if possible) when demands increase. If it is not able or is unwilling to do any of these actions, a supplier and its customers are immediately a production lead time (PLT) away from getting the part needed once inventory echelons are consumed. This cannot be overstated since PLT, especially for aviation weapon system spares, can average from 6 to 8 or easily exceed a year.[13] The bottom line is a supply chain equation not conducive to agile support in the warfighting business: Nonagile Combat Support ($\int x$)[↑manufacturer demand variability] * [↑PLT] * [↑deferred deliveries to the supplier] * [↑passed on costs] * [↑customer back orders]. Results of this kind of algorithm stifle mission capability for warfighters. For a large supplier

like DLA, this situation may occur frequently since it supports highly dynamic customers (military services) subject to no-notice and high operations tempo missions. This drives unexpected demand variability into its supply chain, attempting to support more than 1,350 weapon systems.

On the other hand, smoothing demand variability through a part grouping system (Figure 2) between supplier and manufacturer allows better production planning from the very start across broad groups of items instead of just piecemeal. In this type supply chain, more demand predictability is gained, and production efficiency is achieved based on this predictability. This production efficiency in a dynamic supply chain results in optimum

In this type supply chain, more demand predictability is gained, and production efficiency is achieved based on this predictability.

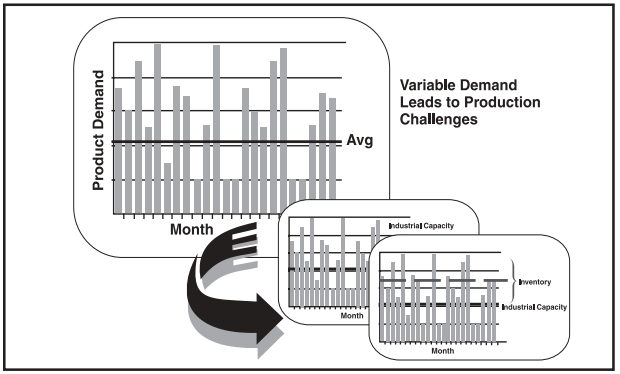

Figure 1. Parts Managed Individually

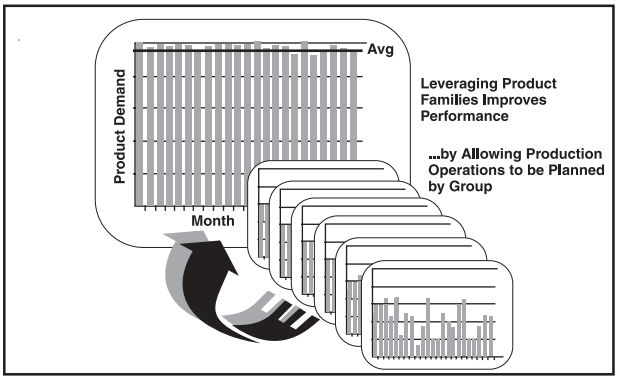

Figure 2. Parts Managed by Part Grouping System

Part Grouping: Angioplasty for the Supply Chain

"Every organization with a supply chain should have contingency plans that help deal with demand surges and interruptions."

production capacity utilization and reduces PLT since items are produced with less impact because of demand spikes or interruptions. The bottom line is a supply chain equation that is conducive to agile support in the warfighting business: Agile Combat Support (***f*x**)[↓ manufacturer demand variability] * [↓PLT] * [↑steady deliveries to supplier] * [↓inventory costs] * [↓customer back orders]. Results of this kind of algorithm are enhanced mission capability for warfighters. In addition, the more done across a broad part grouping supply chain, the more strategic leverage in efficiencies is achieved.

After 11 September 2001, John Rapp, senior vice president of operations for the US Postal Service stated, "Every organization with a supply chain should have contingency plans that help deal with demand surges and interruptions."[14] The part grouping supply chain can actually build in contingency planning by systemically smoothing demand surges or interruptions created by unplanned operations tempo increases in weapon system flying hours, steam time, or tank miles. In doing so, it creates inherent production efficiencies and reduces PLT overall. This is not unlike smoothing blood flow with angioplasty, improving efficiency of the cardiovascular system, and reducing high blood-pressure levels.

Improve Parts Availability and Lower Costs

With improved production efficiency and subsequent reduction in PLT, availability of parts (to include previously hard-to-get parts for aged weapon systems), across a broad part grouping system, remains consistently higher. By doing so, it lowers the need for the supplier and manufacturer to maintain higher inventories of safety-level stocks, lowering holding costs on their end of the supply chain. There are less out-of-stock opportunities since part throughput is more assured, given optimization using common manufacturing processes among supply chain partners. Also, with higher efficiencies lowering PLT, the unit cost of parts is sustained and even reduced. Why? Less production schedule disruptions mean overall reduction in queue time buildup. With this achieved, materiel production setup times are economized because of

efficiencies gained within the common processes used. This drives reduction in machine and production floor setup changes, leading to more efficient use of shift work and less overtime needs, especially during periods of unplanned demand spikes. Overall, the effectiveness in improved parts availability, cost savings achieved with lower holding costs based on less buffer stocks, and lower unit costs because production efficiencies can be passed on to an end user such as the warfighter. The patient begins to experience the benefits of the angioplasty procedure and is back on the road to good health.

Part Grouping Concept Demonstration Results

A part grouping concept demonstration between DLA and Boeing provides an opportunity to study some results.[15] DLA entered into a part grouping supply chain arrangement in 1999 with Boeing to improve its support for spare parts that were low demand density with long PLT. Typically for DLA, these are aircraft weapon system parts. With this premise, Boeing initiated work on its end, focusing on three weapon systems used by the Air Force, Navy, and Marine Corps as a first phase test. These were the F-15 Eagle, F/A-18 Hornet, and AV-8B Harrier II. As part of this new part grouping partnership, DLA provided Boeing a large amount of indicative data on the spare parts coded to systems it managed. Boeing, in turn, studied its manufacturing processes strategically for these weapon systems based on parts families such as wire bundles, sheet metal, machined parts, and tubing.[16] The next steps, as described earlier, were the most demanding. The first cut for these three platforms totaled approximately 340,000 items. From this, Boeing assessed its own manufacturing and associated second- and third-tier vendor bases for common process capabilities. Then it linked this to the parts data it possessed and data provided by DLA to focus down to a reasonable number for testing in a grouping system. By doing so, Boeing brought the group of items down considerably, to approximately 3,500 total.[17] Next, it calculated the probable demands of these individual items (based on historical demand requirements as provided by DLA indicative data) to optimize smoothing

A part grouping concept demonstration between DLA and Boeing provides an opportunity to study some results.

Boeing actually ensured a wider competitive base for vendors that could be expanded into a larger part grouping system in the future.

demand variability for the overall group being considered. It also needed to ensure production capacity for the group was executable from the participating vendor base. Concurrent with all this, Boeing needed to assess, interest, and work with its target vendor base to ensure the quality and feedback to give this innovative part grouping system a good opportunity to perform as envisioned. It found, for example, that it should allow its vendors to submit bids on portions of groupings that best fit their particular processing niche instead of attempting to get an all-inclusive grouping solution. Doing this, Boeing actually ensured a wider competitive base for vendors that could be expanded into a larger part grouping system in the future.[18] This also was a good method to mitigate associated risk for interested vendors because it provided a way to increase its cash-flow without jeopardizing product quality or stretching beyond production capacities, as was mentioned earlier.

The first deliverable of this part grouping system between DLA and Boeing was provided in 2001 and showed positive results. For example, under the category of tubing manufacturing processes, a part group of 84 hydraulic tubes supporting the F-15, F/A-18, and AV-8B realized an overall reduction in PLT of 60 percent, from 345 to 141 days. Overall price reduction across the group was from 8 to 10 percent. Results of specific items within this group were even more impressive. For example, the hydraulic tube shown in Figure 3 and used on the three subject weapon systems had an original PLT of 508 days.

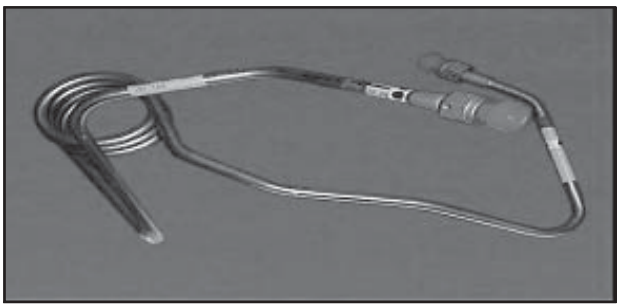

Figure 3. Hydraulic Tube

Under the DLA and Boeing part grouping supply chain, PLT was reduced by 75 percent to 129 days.[19]

The unit cost of this item was also reduced by 30 percent. Over this same period, the efficiencies gained by this part group were able to mitigate an unanticipated spike in demands of 1,000 percent and still deliver to the new PLTs without any increase in cost.[20] Another benefit from this part grouping supply chain partnership was a huge reduction in supplier (DLA) back orders. The rate of back orders for items prior to the concept demonstration was about 38 percent overall. Even with the unanticipated spike in demands during this period under the part grouping system, back orders steadily decreased to about 7 percent overall. What this means is part availability remained consistently high to mitigate increased demands; with the added value of lower PLTs dropping (in aggregate) 60 percent, any newly established back orders now took 204 days less to deliver than it originally did when the parts were individually managed. For the example cited in Figure 3, any newly established back order now took 379 days less to deliver; this is a remarkable 1-year improvement for a critical weapon system part. Other direct benefits to DLA based on this part grouping supply chain were in its F-15 Virtual Prime Vendor[21] support contract, with more assured direct vendor deliveries for those parts included in the part grouping concept demonstration. In fact, any procurement method such as corporate, long-term, and prime vendor contracts would benefit if its line items touch this part grouping arrangement.

Efficiencies gained by this part group were able to mitigate an unanticipated spike in demands of 1,000 percent and still deliver to the new PLTs without any increase in cost.

What other improvements can be potentially envisioned and realized? Some examples could be a reduction in part cannibalization actions, less working capital fund surcharge fluctuations because of lower cost recovery rates, improved scheduled maintenance (operational and depot) based on more precise time-definite deliveries, and increased operational readiness based on reductions in not-mission-capable-supply and maintenance rates. In the context of strategically improving the health of the supply chain for the benefit of the patient (customer), the results seen in this part grouping concept demonstration hold excellent promise.

The end result for the warfighter is improved supply chain health reflected in increased mission capability and readiness.

Conclusion

Reopening supply chain blood flow using *part grouping angioplasty* is colloquially expressed. It can, however, mitigate problems by putting rigor back into a cold industrial base, smoothing variations in part demands, reducing long production lead times, improving availability, and lowering costs of critical weapon system parts. Although much effort is required to enter into this type process, demonstrable improvement in agility of supplier and manufacturer supply chain partnerships can be significant, as seen in the DLA and Boeing part grouping concept demonstration. The end result for the warfighter is improved supply chain health reflected in increased mission capability and readiness.

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Acquisition function focuses on research, development, and acquisition.

Evolutionary Acquisition

Is This Agile Combat Support

Logistics, in its most comprehensive sense, spans activities from research, development, and acquisition, all the way through sustainment of fielded force operations.

Lieutenant Colonel David E. Goss, USAF

Introduction

The emergence of the Air Force Agile Combat Support (ACS) concept raises some interesting questions. What is combat support? What makes it agile? Who is responsible for championing changes in organizations, equipment, training, and processes to achieve the desired results? So far, logistics has been the focus for many of these changes.

Logistics, in its most comprehensive sense, spans activities from research, development, and acquisition, all the way through sustainment of fielded force operations.[1] In the Air Force, this comprehensive definition incorporates two separate functions. The acquisition function focuses on research, development, and acquisition, while the logistics function focuses on supporting and sustaining fielded forces. From one perspective, this functional division makes sense: each function is large and complex in its own right, and the challenges of day-to-day management argue for a simplifying construct. From another perspective, this functional division has limitations: each function may lose sight of the overarching objective, leading to suboptimal performance or even conflicting initiatives.

The Air Force has moved between these two perspectives throughout its history. In the early days of the Army Air Corps, all acquisition and logistics functions were managed by a single command, the Air Corps Materiel Division. As weapon system

The acquisition function has sponsored a major initiative called Evolutionary Acquisition.

complexity grew, the Air Force divided acquisition and logistics responsibility between two commands: the Air Force Systems Command and Air Force Logistics Command. Acquisition and logistics functions were joined again when these two commands were combined to form the Air Force Materiel Command.[2] However, at the Air Staff and Air Force Secretariat, responsibility for acquisition and logistics remains divided between two separate staffs. Both sides champion new initiatives in their areas of responsibility. Just as Agile Combat Support is a current focus of the logistics function, the acquisition function has sponsored a major initiative called Evolutionary Acquisition (EA).

If Air Force acquisition and logistics should be oriented on the same objective under a comprehensive view of logistics, then these two initiatives should be analyzed to determine if they are redundant, complementary, or conflicting. Although they are treated separately, they may impact each other. Likewise, when oriented on an overarching objective, the two initiatives may yield beneficial synergies.

This article will show Evolutionary Acquisition to be both an element and enabler of Agile Combat Support. This conclusion will flow from a two-step analysis of the constructs, first using a direct comparison, then considering them under a comprehensive view of logistics. When compared directly, Evolutionary Acquisition and Agile Combat Support share little in common. However, from a comprehensive perspective, Agile Combat Support offers a unifying framework, bridging current Air Force notions of acquisition and logistics.

The first section of this article provides background on the ACS and EA concepts, focusing on their objectives, processes, and guiding principles. The second section gives an analysis of the relationship between these concepts, first in direct comparison, then from a comprehensive view of logistics. The third section considers implementation challenges raised by the relationship between these two concepts, focusing especially on Evolutionary Acquisition. Finally, the fourth section draws conclusions and provides recommendations as a result of this analysis.

Background

Agile Combat Support and Evolutionary Acquisition are recent initiatives, both emerging within the last 5 years. Both responded to warfighter needs for responsive, flexible support processes and can be described in terms of their objectives, processes, and guiding principles. However, responsibility for the ACS initiative falls to the logistics function in the Air Force, while Evolutionary Acquisition is sponsored by the acquisition function.

Agile Combat Support

Guided by its Secretary and Chief of Staff, the Air Force established Agile Combat Support as one of its six core competencies in its 1997 vision document, *Global Engagement: A Vision for the 21st Century Air Force*. Agile Combat Support was seen as a force multiplier for the other core competencies, with the objective of "allowing combat commanders to improve the responsiveness, deployability, and sustainability of their forces."[3]

The Air Force Deputy Chief of Staff for Installations and Logistics further refined the ACS concept in the Air Force logistics support plan. Agile Combat Support has six master processes: readying the force, preparing the battlefield, positioning the force, employing the force, sustaining the force, and recovering the force. These processes are guided by seven core principles: responsiveness, rapid deployment and sustainment, time-definite delivery and resupply, effective beddown and sustainment, reachback, leveraging information technology, and efficient installation support.[4] In short, "It encompasses all the functions inherent in making and sustaining combat power capable anywhere in the world."[5]

Having considered the background of Agile Combat Support, the focus now turns to the second concept: Evolutionary Acquisition.

Evolutionary Acquisition

Evolutionary Acquisition is a Department of Defense (DoD) strategy for buying new or improved operational capabilities, typically weapon systems. Its objective is to shorten the time to field an initial increment of capability (called the acquisition cycle time), "followed by subsequent increments of capability over time that

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Evolutionary Acquisition: Is This Agile Combat Support

DoD policy guidance on preparing EA strategies suggests four key processes.

accommodate improved technology."[6] The end result should be agility in the acquisition process, both in the time needed to field capabilities and the ability to exploit current technologies.[7]

In early 2001, DoD policy mandated Evolutionary Acquisition as "the preferred approach to satisfying operational needs."[8] The Assistant Secretary of the Air Force for Acquisition sponsors this initiative as part of the Air Force "push for 'Agile Acquisition.'"[9]

Evolutionary Acquisition has not yet been characterized in terms of master processes and core principles. However, DoD policy guidance on preparing EA strategies suggests four key processes: generate requirements, assess technology maturity, prepare cost estimates, and evaluate supportability.[10] DoD guidance further suggests four EA principles: "earlier delivery [of operational capabilities], agility, affordability, and risk reduction."[11]

This background provides the context for analysis of the relationship, if any, between the concepts of Agile Combat Support and Evolutionary Acquisition.

Analysis

An analysis of the ACS and EA concepts yields insights into their similarities and differences. The analysis proceeds in two steps. In step one, the two concepts are compared directly with respect to their objectives, processes, and principles. In step two, they are considered under a comprehensive view of logistics.

When compared directly, Agile Combat Support and Evolutionary Acquisition have many more differences than similarities, so the comparison provides little insight into any relationship between them. However, from a comprehensive perspective of logistics, Agile Combat Support provides a unifying framework, bridging current Air Force notions of acquisition and logistics. Evolutionary Acquisition is then shown to be both an element and enabler of Agile Combat Support.

The first analysis step is a direct comparison of Agile Combat Support and Evolutionary Acquisition. Tables 1 and 2 and summarize the objectives, processes, and principles of each concept.

• Objective: Improve responsiveness, deployability, and sustainability of forces				
• Processes:				
Ready the force	Prepare the battlefield	Position the force	Employ the force	Recover the force
• Principles: Responsiveness Rapid deployment and sustainment Time-definite delivery and resupply Effective beddown and sustainment		Reachback Leveraging info technology Efficient installation support		

Table 1. Agile Combat Support

Objective: • Shorten the time to field an initial increment of new or improved operational capability and follow with additional increments (blocks) incorporating improved technology.
Processes: • Generate requirements • Assess technology maturity • Prepare cost estimates • Evaluate supportability • Principles: • Earlier delivery of capabilities • Agility • Affordability • Risk reduction

Table 2. Evolutionary Acquisition

The ACS objective focuses on getting the force to the fight quickly (measured in hours or days) and keeping the force in the fight at minimum cost and risk.

Step One: Direct Comparison

The objectives of Agile Combat Support and Evolutionary Acquisition share an emphasis on responsiveness to warfighter needs. However, as illustrated by a recent RAND study,[12] the ACS objective focuses on getting the force to the fight quickly (measured in hours or days) and keeping the force in the fight at minimum cost and risk. Such an approach takes operational force capabilities as givens, then evaluates options for changes in "traditional logistics functions of supply, transportation, maintenance, contracting, and logistics plans," along with other base support functions, to meet required time lines.[13] In a sense,

The EA objective focuses on buying a measurable improvement in force capability as quickly as possible (measured in months or years), at minimum cost and risk.

then, the ACS concept reflects its sponsorship by the Air Force logistics function. Its focus is self-limiting, since its responsibility begins at the point when combat systems are fielded for operational use.

In contrast, the EA objective focuses on buying a measurable improvement in force capability as quickly as possible (measured in months or years), at minimum cost and risk. This approach evaluates technological and contractual options, including using commercial technology, to meet required time lines. For example, several current acquisition programs have used "commercial technology and innovative contracting arrangements" to dramatically reduce acquisition cycle times.[14] This concept also reflects its sponsorship, this time by the acquisition function. It also assumes a self-imposed limited focus, since its responsibility *ends* at the point where combat systems are fielded for operational use.

Beyond comparing the objectives of the two processes, even more contrasts are apparent when comparing their processes and principles. As shown in Tables 1 and 2, Combat Support and Evolutionary Acquisition are characterized differently, so direct comparison yields little insight into any relationship between them. The relationship is obscured by the inward-looking functional focus of the sponsors of each concept. Gaining more insight requires a different comparison approach.

Fortunately, a more useful approach is at hand: instead of directly comparing Agile Combat Support and Evolutionary Acquisition, consider them using a comprehensive view of logistics.

Step Two: A Comprehensive View

A comprehensive view of logistics, coupled with the ACS processes, provides a useful framework for understanding the relationship between Agile Combat Support and Evolutionary Acquisition. The ACS processes are ready the force, prepare the battlefield, position the force, employ the force; sustain the force, and recover the force. This is a farsighted and overarching set of processes, even though they were crafted in the context of traditional logistics functions (supply, transportation, maintenance, contracting, and logistics plans). Within these processes, the Air Force logistics plan contains key linkages beyond

traditional logistics, extending into the acquisition function. For example, the plan's discussion of readying the force and sustaining the force includes references to technology development and acquisition.[15] Thus, Agile Combat Support is seen to be more than just traditional logistics; it provides a framework for bridging both the Air Force acquisition and logistics functions and parallels a comprehensive view of logistics.

With this perspective, Evolutionary Acquisition can be seen as both an element and an enabler of Agile Combat Support, opening new opportunities for the Air Force. First, Evolutionary Acquisition is an element of Agile Combat Support since it is an approach for readying the force. If its potential is realized, the agility and responsiveness of Evolutionary Acquisition could offer warfighters new alternatives. In one case, a responsive acquisition process may allow warfighters to obtain new force capabilities rapidly in the face of emerging threats. In another case, warfighters may elect to update or replace weapon systems for the sake of agility in the field, rather than retain old systems and try to improve the traditional logistics support functions. Second, Evolutionary Acquisition could enable improvements in sustaining the force. In particular, establishing reachback capabilities and leveraging information technology (both core principles of Agile Combat Support) will require the acquisition of new or modified logistics information systems. An EA approach may allow the problem to be broken into pieces, with meaningful improvements in Agile Combat Support fielded much sooner.

Evolutionary Acquisition is an element of Agile Combat Support since it is an approach for readying the force.

However, viewing Evolutionary Acquisition as an element and enabler of Agile Combat Support illuminates some challenges for the Air Force. Among these challenges is a need to focus both the Air Force acquisition and logistics functions on the same overarching objective. Doing so demands a fundamental understanding of the relationship between Agile Combat Support and Evolutionary Acquisition, driving home the need for proper logistics support planning in acquisition programs.

Challenges

Without proper planning, Evolutionary Acquisition could and does have negative impacts on Agile Combat Support.

Evolutionary Acquisition: Is This Agile Combat Support

The C-17 experience exemplifies the relationship between Agile Combat Support and Evolutionary Acquisition.

Every acquisition program accomplishes logistics support planning, addressing each of ten logistics support elements.[16] An EA strategy, by multiplying the blocks of weapon systems in the field at any given time or by driving frequent change-outs of equipment, places a premium on sound logistics support planning. For example, the C-17 program uses an EA strategy and produces a new block of aircraft each year. However, the program has had difficulty providing new blocks of support equipment to maintenance training units in time to meet required training time lines.[17]

The C-17 experience exemplifies the relationship between Agile Combat Support and Evolutionary Acquisition, especially the hazards of not acknowledging that relationship during an acquisition program's planning stages. This insight, coupled with the analysis and background discussed earlier, sets the stage for offering conclusions and recommendations.

Conclusion and Recommendations

This article has shown Evolutionary Acquisition to be both an element and an enabler of Agile Combat Support. When oriented on an overarching objective, the concepts of Agile Combat Support and Evolutionary Acquisition yield beneficial synergies. In this case, the overarching concept is a comprehensive view of logistics; the ACS processes aptly delimit the scope of that view.

The concepts of Agile Combat Support and Evolutionary Acquisition share similarities and differences. Both are recent initiatives, emerging since 1997. Both share an emphasis on responsiveness to warfighter needs, and both can be described in terms of their objectives, processes, and guiding principles. However, both also reveal their respective heritages, one rooted in the Air Force logistics function, the other springing from the Air Force acquisition function. A two-step analysis of the concepts highlighted these similarities and differences. In step one, the concepts were compared directly; in step two, they were considered under a comprehensive view of logistics.

A direct comparison of Agile Combat Support and Evolutionary Acquisition revealed more differences than

similarities and gave little insight into any relationship between them. This step suggested the need for a different method for analyzing these concepts, and a comprehensive view of logistics provided that method. This approach revealed Agile Combat Support provides a unifying framework bridging current Air Force notions of acquisition and logistics.

The Air Force encounters both opportunities and challenges by considering Evolutionary Acquisition to be both an element and enabler of Agile Combat Support. In terms of opportunities, Evolutionary Acquisition presents new alternatives in two ACS processes: readying the force and sustaining the force. Regarding readying the force, a responsive acquisition process offers warfighters the capability to gain new force capabilities quickly or replace old weapon systems to improve support agility in the field. Regarding sustaining the force, Evolutionary Acquisition can make combat support improvement programs (such as reachback capabilities and logistics information technology) more successful and responsive to urgent needs.

The Air Force encounters both opportunities and challenges by considering Evolutionary Acquisition to be both an element and enabler of Agile Combat Support.

In terms of challenges, the incremental nature of EA strategies puts a premium on sound logistics support planning in acquisition programs. As illustrated by the C-17 program, EA's emphasis on frequent block upgrades of major system components leaves little margin for error in schedule management and is particularly unforgiving when interlocking relationships are overlooked.

These opportunities and challenges suggest two recommendations for taking full advantage of Evolutionary Acquisition as both an element and an enabler of Agile Combat Support. First, Air Force acquisition and logistics leaders (Air Force Materiel Command Commander, Secretary of the Air Force, Acquisitions, and Air Force Deputy Chief of Staff for Installations and Logistics) should recognize the relationship between Evolutionary Acquisition and Agile Combat Support. All three should use the ACS processes as the unifying framework bridging acquisition and logistics functions. All three should craft strategic plans in light of these processes and ensure initiatives are not duplicative or operating at crossed purposes. Most

Concepts of Agile Combat Support and Evolutionary Acquisition finally offer a way to unify effort through an overarching objective.

important, all three should agree to modify acquisition and logistics training, using ACS processes as the framework for tying together specialized functions under a comprehensive view of logistics.

Second, Air Force depot commanders should create a strategic planning organization (or use an existing organization, if appropriate) for guiding investments in ACS improvements. This organization should recommend EA approaches for buying improvements in sustaining the force, such as component improvements or new information technology. This organization should also identify when these activities are poor investments, and the funds should be consolidated and used to replace old weapon systems with new ones (bought using an EA approach).

Throughout its history, the Air Force has been grappling with its concept of logistics, alternating between a comprehensive view and a divided view. When taken together, the concepts of Agile Combat Support and Evolutionary Acquisition finally offer a way to unify effort through an overarching objective.

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Does the Coalition Theater Logistics, Advanced Concept Demonstration Project Meet Multinational Logistics Data Sharing Requirements?

Supporting the Fleet in the 21st Century

Evolutionary Acquisition and Logistics

The traditional, bureaucratic rules have been tossed aside, and a new *if it isn't against the law* mentality rode into town.

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The New Mentality—Reality-Based and Evolutionary Acquisition

The Air Force acquisition world has been turned upside down. The traditional, bureaucratic rules have been tossed aside, and a new *if it isn't against the law* mentality rode into town. Does this environment portend a return to the days of the Wild West and a scenario where every program does as it darn well pleases? Of course not. But, in a recent policy letter, Dr Marvin R. Sambur, Assistant Secretary of the Air Force, tries to instill a sense of urgency and innovation from the acquisition community with a battle cry for ushering in a new emphasis on Reality-Based Acquisition. Under his vision, there are two overarching goals: "to shorten acquisition cycle time and to gain credibility within and outside the acquisition community." Toward that end, a list of commander's intent statements accompanied these goals, the first of which stated, "Program managers will ensure full compliance with the law; however, overrestrictive implementation that goes beyond what is required in statute must be challenged." Dr Sambur's policy letter also prescribes Evolutionary Acquisition (EA) as the "preferred strategy for achieving the commander's intent."[1]

The new mentality impacts product suport, logistics, and sustainment.

At its core, Evolutionary Acquisition is strategy based on the delivery of needed requirements by providing successive increments of increasing capability. Its bottom line is to shorten the acquisition cycle by incorporating mature, quickly garnered technologies to produce an initial capability, then increasing the system's capabilities in subsequent increments over time. It provides the warfighter an improved capability, at a much quicker pace. In addition, it enables the United States to continue striving for the best, in increments, without depending solely on aging systems and outmoded technologies while waiting for a quantum leap or *big bang* (Figure 1). The process that builds this capability within each increment is called spiral development. The overall goal is to decrease acquisition response time in a 4:1 ratio by delivering new warfighting capabilities in about 5 years.

Taken together, the incremental deliveries under an EA strategy, coupled with the spiral development process, are designed to deliver useful and supportable technology to the warfighter faster and more reliably than the traditional single-step-to-full-capability acquisition approach.

Impact on the Support Community

Does this new mentality impact product support, logistics, and sustainment?[2] You bet. In some very important respects though, basic requirements are still the same for the sustainment community. Anytime a weapon system or product is delivered to the field, it must be fully supportable, as if it were the final delivery of the system. It does not matter if it was the result of a faster acquisition process. Nor does the fact it is being delivered in increments, rather than a full-up final version, change this dynamic. A weapon system delivered to the field without support capability is little more than a static display. Lieutenant General Michael Zettler reinforced this necessity during a panel session at a recent conference:

> I have no trouble with the program manager who is out there with a product put together to deliver a capability and to break a lot of paradigms along that path. I have a lot of trouble, though, when we just say throw out all the rules because I've got to make sure that what you field is supportable at Khandahar and Bagram and other places around the world like that. Or even at places like Seeb, where we've been

operating a few years, or Prince Sultan Air Base. And it has got to be operated by a young man or woman with a high school education and 6 weeks of basic training, and 20 weeks of technical training, and 4 weeks of field training on that specific platform. And it has got to be worked. And he's got to have books to work it by. And he's got to understand it. And yes, we'll put some technical assistance out there in the form of contractor experts. And that's fine for platforms that are in very small numbers, but when you start to develop and field multiple systems and multiple squadrons of those systems, that's got to be supportable. It's got to work within the system. We've got to have the capability to have young men and women take care of it. And it's got to be reliable enough that the warfighter when he says go do it, it goes and does it.[3]

While some basic truths never change, Evolutionary Acquisition does, at the same time, pose major new and unique challenges for the support community. Planning can be more complex when attempting to support multiple increments, rather than one final delivery. The issues of configuration control and interoperability rise rapidly to the forefront of the planning effort, as incremental introduction of warfighting capability increases the chances of multiple versions of weapon systems being in use simultaneously. Proper planning should allow for a

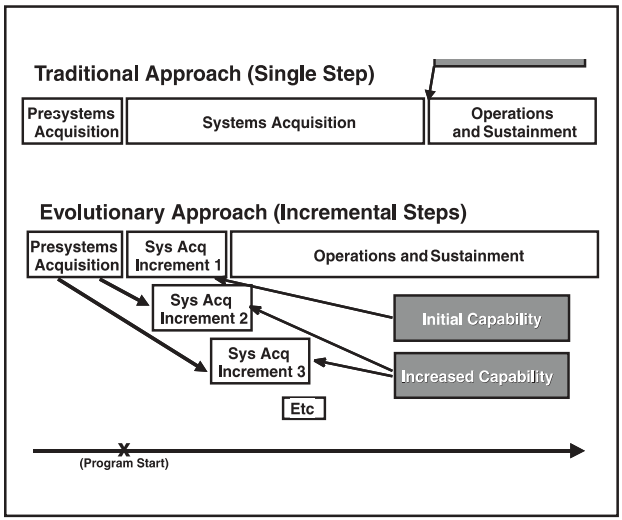

Figure 1. Traditional Versus Evolutionary Approach

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Proper planning should allow for a much more structured approach to configuration managemen.

much more structured approach to configuration management, which should, in turn, mitigate the risks associated with multiple versions and interoperability. Ensuring full-up support capability is garnered more rapidly to match the quicker delivery of a weapon system operational capability is also among the most basic of those challenges. For these reasons, thorough logistics support planning and finely tuned, integrated, and coordinated support execution are even more important than in the past.

Taking on the Challenges of Evolutionary Acquisition

How does the support community approach and overcome these challenges? More specifically, what can the support planner do to ensure each increment can be immediately and fully supported, despite greater complexity? The bad news is there has been little official guidance offered to this point on supportability planning for Evolutionary Acquisition. The good news is that the lack of official guidance leaves plenty of room for innovation and flexibility. Further good news is that logisticians already have been preaching and practicing a basic framework for years, which can enable success, even in this changed acquisition environment.

Logisticians have always understood that up-front sustainer involvement enhances an acquisition program. When brought in early enough, support planners can offer design recommendations that ensure a weapon system is more easily supportable at a reduced total life-cycle cost. Unfortunately, in the pre-EA days, early and active sustainer involvement was not always a priority, as there often seemed to be more pressing needs. After all, in the old paradigm, the need to support the system was still many years away. Under EA's quicker delivery of systems, however, early sustainer involvement becomes imperative. If the weapon system is to be operated and supported sooner, then detailed support planning must be integrated with overall system planning at the earliest stages—even in the first initial capabilities documents and capabilities development documents developed by the warfighter.

To offer the best advice to the warfighter, the product support planners must keep attuned to the latest support

concepts, technology advances, and availability. A good support planner will be aware of products already on the market or included in other weapon systems that can be integrated quickly to enhance the support of the proposed weapon system. They will also comprehend the status of logistics and product support research in the Air Force Research Laboratory, as well as the latest policy initiatives in Air Force Materiel Command, Air Staff, and Department of Defense (DoD) logistics. Based on this knowledge, the support planner must be able to provide the warfighter with advice on what can be procured quickly from the support perspective and what the impact will be on the warfighter. There may be products readily available that can reduce or obviate the need for some traditional support but require a larger initial investment. The warfighter needs to be provided with those options. On the reverse side, it is possible a system can be delivered rapidly under Evolutionary Acquisition, but the supply chain cannot be made ready to support it soon enough. Again, the warfighter must be informed of the constraints and tradeoffs, along with feasible alternatives. In any case, the product support professional must balance the need for agile acquisition with the absolute requirement of Agile Combat Support at the operational base or the deployed environment, because systems procured quickly are not worth the effort if they cannot be supported.[4]

The support planner must be able to provide the warfighter with advice on what can be procured quickly from the support perspective and what the impact will be on the warfighter.

The decisions made, actions planned, impacts anticipated, and costs projected should ultimately be spelled out clearly in a product support management plan (PSMP)[5] and appropriately included in the Single Acquisition Management Plan (SAMP) for the weapon system. Only by doing so can milestone decision authorities, acquisition strategy panels, and Air Force corporate review panels adequately assess the proposed system of systems to ensure the warfighter can be satisfactorily supported before approving progression into subsequent phases of the acquisition process. The PSMP should be reviewed, updated, and approved at program decision reviews for increments that change significantly from the approved baseline.[6]

The ten ILS elements separate the logistics chain into manageable chunks.

ILS Elements and Evolutionary Acquisition

Another traditional framework—Integrated Logistics Support (ILS)—remains very useful for ensuring the full range of support is considered and included, especially in the more complex EA environment. The ten ILS elements separate the logistics chain into manageable chunks. Maintenance planning; supply support; design interface; packaging, handling, storage, and transportation; manpower and personnel; support equipment; technical data; training and training support; facilities; and computer resources support comprise those elements, as depicted in Figure 2. The process of ensuring a weapon system is fully supportable includes appropriately addressing, integrating, and balancing each of these elements. In the following paragraphs, we will examine each of the ILS elements individually and briefly consider their unique impacts on a program using an EA strategy. These characterizations will not be exhaustive or comprehensive; instead, they will be a summation of some of the key points for actual program teams to consider in developing alternative support strategies in an EA environment.

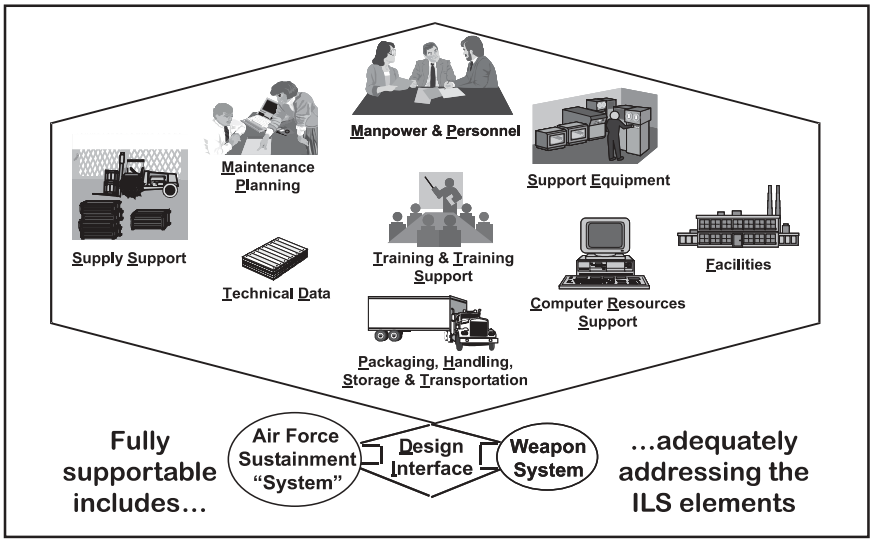

Figure 2. The Ten ILS Elements

Maintenance Planning is the process of describing requirements and tasks to be accomplished for achieving, restoring, or maintaining the operational capability of a system, equipment, or facility. The maintenance concept employed under Evolutionary Acquisition is not limited to any predetermined subset of those available to traditional acquisition programs. However, with the planned, methodical progression from the first increment to the last, the selection of two versus three levels of maintenance, the provider of base-level maintenance services for new and peculiar items, and the Source of Repair Assignment Process (SORAP) recommendation for the provision of depot-level maintenance take on added elements of complexity. Alternatives range from interim contractor support (ICS) for short periods, contractor logistics support (CLS) for longer periods, organic support, or public and private partnerships, whichever combination makes the most economical and mission support sense. It is important to recognize that the complexities of multiple increments do not necessarily drive the default decision toward using a contractor as the maintenance provider. Any potential contractor must face the same complexities, and as such, it may prove to be cost prohibitive to contract for such services. That said, only after a thorough repair level analysis (RLA) is completed will it be clear whether the maturity, stability, and complexity of the system design is appropriate for a contractor-provided maintenance scenario over that of an organic source.

The maintenance concept employed under Evolutionary Acquisition is not limited to any predetermined subset of those available to traditional acquisition programs.

Supply Support planning is used to acquire, catalog, receive, store, transfer, issue, and dispose of items to meet the user's peacetime and wartime requirements. In an EA environment, a supply support for the initial increment is likely to be provided through an ICS structure, without necessarily putting all the required supply management data interfaces in place. After the initial increment, the single manager will need to consider whether the priority of the mission, mission requirements, and date the increments need to be in operation can be met through normal organic provisioning processes, further interim contractor logistics support (using the Reformed Supply Support Process), or permanent contractor logistics support. Supply support may become more standardized and

organically provided as the program moves to subsequent increments, the design stabilizes, and operational usage increases. Unique processes should be minimized with subsequent increments.

Design Interface integrates logistics-related readiness, combat capability, and supportability design parameters into system and equipment design.

Design Interface integrates logistics-related readiness, combat capability, and supportability design parameters into system and equipment design.[7] This element is often an overlooked element, yet it is far and away the most powerful one. By leveraging support considerations into system design, the greatest influence is made on logistics support, life-cycle cost, and the ability to carry out sustained warfighting missions. If spares and support equipment are to be more common, the system must be designed that way. If the new components are to be more reliable than their predecessors, they must be designed that way. If maintenance is to be simplified, the system must be designed that way. Evolutionary Acquisition provides greater opportunity for driving weapon system capability improvement into designs, as the system design is programmed for change more often. If not planned properly, however, the potential for significantly greater life-cycle costs exists, if each increment drives costly changes to the existing logistical infrastructure. Historically accepted estimates tell us that, once designed, as much as 70-80 percent of a system's total life-cycle cost is predetermined. To accommodate multiple increments under Evolutionary Acquisition, the initial design should, therefore, be as reliable, flexible, adaptable, scalable, supportable, and transportable as current technology allows. Under an EA strategy, the opportunity to improve reliability on a fielded system happens much sooner and more often in a program as design changes with each increment could lower total ownership costs, as well as improve operational performance.

Packaging, Handling, Storage, and Transportation (PHS&T) planning determines environmental, preservation, storage, and transportability requirements and methods to ensure elimination or minimization of damage to the system or support infrastructure. Transportability is a design consideration to ensure all system equipment and support items can be delivered to the battlefield or the point of operational use effectively,

efficiently, and safely. Under Evolutionary Acquisition, earlier delivery necessitates earlier transportability analysis. Operational delivery and use of the system in the earlier phases of development, combined with the greater likelihood of contractor inventory control points and other support infrastructure differences, impact transportation decisions. As a result, the program office must contact and work with its center's transportation specialist much earlier in the program, long before any operational use or movement is considered. In addition, PHS&T requirements will need to be reevaluated for each increment to determine if any new or unique needs must be met. Numerous configuration changes (physical, weight, dimensions, hazardous material, security classification or item fragility changes), possibly resulting in new national stock numbers, will also impact PHS&T and transportability analysis. With multiple configurations possible, the number of container and packaging designs and the importance of clear label marking and total asset visibility increase significantly. Since sound PHS&T elements are vital in both peacetime and contingency operations, system designs should specify maximum mobility footprint parameters.

With multiple configurations possible, the number of container and packaging designs and the importance of clear label marking and total asset visibility increase significantly.

Manpower and Personnel planning identifies and acquires military and civilian personnel with skills and grades required to operate and support the system over its planned lifetime in both peace and war. The needed manpower and personnel (the numbers, skills mix, and grade levels) are influenced by decisions made in other ILS element considerations. As a system evolves through the increments, continuing efforts to simplify man and machine interfaces and utilization of built-in test and fault isolation devices can reduce, at least at the organizational level of maintenance, the skill levels required of personnel who operate and maintain those systems. Accomplishing the logistics support mission in the most efficient and economical way should be a primary focus in determining manpower requirements for each increment.

Support Equipment (SE) is all the equipment required to support the operation and maintenance of weapon systems. To the extent possible, support equipment and the systems they support should be designed such that the

Support planners and single managers should look across systems for common SE opportunities.

planned, future system increments under Evolutionary Acquisition do not drive extensive changes to the equipment needed to keep said items applicable and operational. There is a compelling benefit to having common aerospace ground equipment, munitions equipment, test equipment, and so forth. Thus, support planners and single managers should look across systems for common SE opportunities. In cases where a system change is needed, the ideal scenario would include simultaneous upgrades to all fielded systems and related support and test equipment. This reality also tends to suggest an extensive use of support equipment with modularity and scalable capacity such that upgrades are easier to execute.

Technical Data includes recorded scientific or technical information. Providing access to technical data can often be expensive and is, therefore, often considered a ripe opportunity for cost savings in new programs. However, the high cost is driven by its high value, and this decision should not be taken casually. While it may seem expensive, if access to data is not acquired when the design becomes stable, the production of spares in the future may not be competitive, and organic repair may not be possible. If the government's right to access technical data is a stipulation in the award of the basic weapon system contract, many sustainment problems can be precluded. Therefore, access to the full range of technical data should, at the very least, be priced and made available for government consideration and purchase. The decisions for each increment should be a result of the support concept and not vice versa, and clearly, the data costs will be a key consideration in that decision.

Training and Training Support planning considers processes, procedures, curricula, techniques, training devices, simulators, and other equipment needed to train personnel to operate and maintain a weapon system. Training needs should be considered and integrated with any program's flow from the first increment through the last increment. As systems progress from one increment to the next, training needs must be identified, funded, and initiated a lead time away from implementation to avoid negative impacts on operational capability. Ideally, if all

systems and associated equipment are retrofitted or replaced in concert with the introduction of the new increment, the training (both operator and logistics) should be completed prior to initial operating capability of the new increment.

Facilities as an ILS element ensure that planners define necessary facilities or facility improvements for new acquisitions and determine locations, space, utilities, environmental, real estate, and equipment needs. The facility requirements associated with fielding new systems or associated future increments warrant considerable analysis and planning. Fairly unique to this element are the type of funding and lead times associated with constructing new facilities or renovating existing facilities to support system beddown. Normally, military construction (MILCON) funding (3300 appropriation) is used for facility construction. These funds are planned and programmed for by the MAJCOM acquiring the new system, with support from the system program office. MILCON funds are authorized and appropriated apart from acquisition program dollars. In addition, the calendar time it may take to get new facilities constructed can be years in the making. The lead time required to budget, design, and construct facilities, while system requirements may not yet have been fully defined, further complicates the rapid modification of this logistics support element from one EA increment to the next. Given these facts, minimizing the need for new facilities to support system beddown and the need for adequate lead time for MILCON budget requirements should be given additional weight in early program planning and design selection activities.

The facility requirements associated with fielding new systems or associated future increments warrant considerable analysis and planning.

Computer Resources Support (CRS) encompasses the facilities, hardware, software, documentation, manpower, and personnel needed to operate and support mission-critical computer hardware and software systems. CRS is a critical enabler in most, if not all, military systems. Whether embedded in the fielded system and needing support or external to the weapon system (for example, part of the data management system or support equipment for supporting the fleet), computer resources can make or break the ability of the system to reach its operational potential. It is common knowledge that computer technologies often face

The facility requirements associated with fielding new systems or associated future increments warrant considerable analysis and planning.

a generational change every 18-24 months, so systems, especially those using an EA acquisition approach, must give significant consideration to planning for these changes. Whether systems are significantly upgraded or replaced entirely, the logistics support plan needs the flexibility and preparedness to deal with these coming changes. Design considerations in this area include, but are not limited to, such items as sufficient spare memory, reserved physical space, weight allowances, cooling capability, modularity, open systems architectures, and training and training support.

Other Important Support Considerations for Evolutionary Acquisition

The facility requirements associated with fielding new systems or associated future increments warrant considerable analysis and planning. There are other related considerations. Configuration management (CM), for instance, is not one of the ILS elements but is another crucial consideration, especially so under an EA scenario. It is one that touches several, if not all, ILS elements.

In the traditional approach, configuration management is already an important issue, and there can be multiple configurations of weapon systems in the field. Evolutionary management magnifies this version issue, making good configuration management even more important and requiring a more structured management approach. As the system progresses through the increments, the process by which the changes are planned, documented, executed, monitored, and communicated (that is, the CM process) is critical to the success of the overall program. If done properly, it will allow for orderly implementation of the improvements to a weapon system over time. Therefore, some of the challenges with interoperability and multiple versions at a single location could be better managed and mitigated. Some unique provisions should be considered in the CM plan. Planners may or may not decide to retrofit previous versions, but they must think out and account for all support implications. The Configuration Control Board (CCB) probably should be stood up earlier in the acquisition process. System and functional reviews will

happen earlier, so the CCB should be in place earlier to support them. There is likely much more activity in the CCB under Evolutionary Acquisition than in a single-step approach. The CCB's membership probably should be broader than under a single-step approach to address the orderly upgrade of the system through the increments. Consideration also should be given to making the CCB a relatively permanent, standing body. As such, it would provide more consistency throughout the program, from one increment to the next. With at least the core members of the CCB formed as a standing body, assumptions, analyses, and decisions previously made would need to be revisited less often, and a consistent plan would be more likely to be executable through to the final increment.

Corporate reviews remain an essential consideration: Evolutionary Acquisition does not eliminate them, even though many feel some of these reviews are burdensome and could slow down an EA process. Such reviews are necessary for many reasons:

- To comply with laws, policies, and strategies (for example, core, 50/50, depot-maintenance strategy, public-private partnerships).
- Because linkages between weapon systems are becoming greater. Many systems will be designed to work as systems of systems in the near future, so changing a system or its support structure could have significant impacts on other systems.
- To adequately assess the impact of each increment on the entire supply chain supporting the weapon system. Though the supply chain was capable of supporting a previous increment, it may not be capable of supporting future increments without additional planning. There is potential for different bottlenecks or gaps to surface in the supply chain with each new increment.
- To enhance leveraging in the purchase of goods and services involved with each increment. As one example, the strategic sourcing initiative has demonstrated, when government organizations and programs join forces to manage suppliers, there is potential for leveraging buying power to reduce delivery times, improve product performance, and decrease or stabilize prices.

The CCB's membership probably should be broader than under a single-step approach to address the orderly upgrade of the system through the increments.

Thus, system program offices, single managers, and logistics specialists cannot become individual stovepipes, fiefdoms, or silos under Evolutionary Acquisition and Reality-Based Acquisition. Corporate reviews help preclude this and look at the enterprise-wide picture. While

The PBL initiative goes hand in hand with Evolutionary Acquisition.

corporate reviews may not be eliminated, they could always benefit from becoming more agile and streamlined under Evolutionary Acquisition.

One final consideration is also worthy of mention. In many respects, the performance-based logistics (PBL) initiative goes hand in hand with Evolutionary Acquisition. Performance-based logistics is already DoD's preferred approach for implementing product support. Under performance-based logistics, product support professionals negotiate logistics performance agreements with the operational customers and then build incentive-based performance agreements with commercial and organic providers, allowing them flexibility to build, accomplish, and improve support in a timely fashion. The goal of performance-based logistics is to create a reliable support system that reduces the need for and cost of logistics. It also tries to develop a maintainable system that reduces the need for resources, such as manpower, equipment, and spares required to support operational performance. Performance-based logistics attempts to

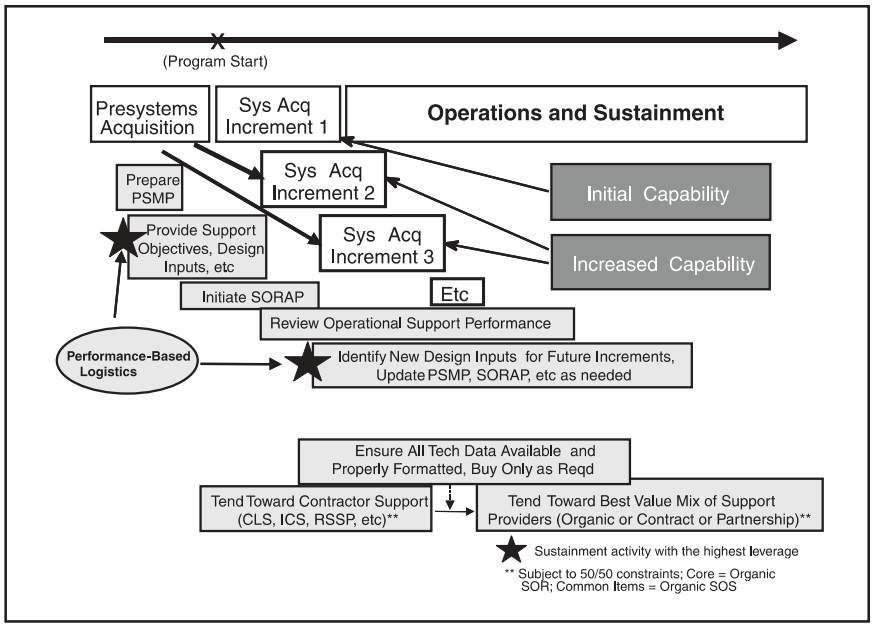

Figure 3. Summary—Sustainment for Evolutionary Acquisition

reduce not only the resource requirements for logistics but also the requirement for logistics itself.[8]

Conclusion

Evolutionary Acquisition is a strategy to provide the warfighter with improved, militarily useful capabilities delivered more rapidly. The strategy is an essential part of Dr Sambur's Reality-Based Acquisition policy that focuses on shortening acquisition time and increasing credibility to the warfighter. Though the acquisition environment has changed, the basic support framework probably has not changed much. With the faster fielding of successive increments, however, support complexity has certainly increased. Configuration management deserves increased attention, as Evolutionary Acquisition is likely to create multiple versions of the same system. At the same time, each increment must be fully supportable in an affordable manner. There should be no doubt that early logistics planning in an EA environment is more important than ever. Early development and continuous assessment of the Product Support Management Plan enhances this planning, as do corporate reviews. PBL strategies help give incentive to contractors to provide innovative logistics solutions, and the ILS elements continue to provide a useful framework to plan a robust range of support over a program's life cycle. Figure 3 overlays some of the key support activities on a generic program life cycle. Any member of the acquisition and sustainment communities would do well to understand these relationships and stay tuned to the evolving policies in this area over the coming years.

Evolutionary Acquisition is a strategy to provide the warfighter with improved, militarily useful capabilities delivered more rapidly.

Notes

1. Marvin R. Sambur, Assistant Secretary of the Air Force (Acquisition), "Reality-Based Acquisition System Policy for all Programs" memorandum for MIDAs, FADs, PEAs, and DACEs, 4 Jun 02.
2. For the purposes of this article, product support, logistics, and sustainment are considered relatively synonymous. It can be defined as "the entire package of support functions necessary to maintain the readiness of and operational capability of weapon systems, subsystems, end items, and support systems" throughout the life-cycle of a weapon system, Air Force Regulation 63-107, 29 May 01.

3. Lt Gen Michael Zettler remarks during panel discussions at the Acquisition and Logistics Excellence Week seminar at Wright-Patterson AFB, Ohio, 21 Oct 02.
4. Some concepts and products that could enhance faster support capability for new weapon systems include prognostics, increased reliability and maintainability, common support equipment, and open systems architecture.
5. Reference Air Force Instruction 63-107, section A2.4 for further information. At the time of this writing, there has been some debate on whether a PSMP should continue to be required by regulation under Reality-Based Acquisition. It is the opinion of the authors, however, whether required or not, a big picture, long-term support strategy is extremely beneficial for the sustainment of a weapon system, and the PSMP provides a good avenue for that.
6. At the time of this writing, there has been some debate on whether a PSMP should continue to be required by regulation under Reality-Based Acquisition. It is the opinion of the authors, however, whether required or not, a big picture, long-term support strategy is extremely beneficial for the sustainment of a weapon system, and the PSMP provides a good avenue for documenting those plans.
7. There are many parameters: reliability, maintainability, and deployability, sustainability, standardization and interoperability, fuel, utility, and energy management, testability, dependability, transportability, durability, availability, survivability, integrated diagnostics effectiveness, transportability, accessibility, spares support, mission effectiveness, serviceability, software reprogramability, level of repair, industrial support base, support equipment, inspections, human factors, corrosion, physical obsolescence, hazardous material management, software speed and efficiency, calibration, revised tactics, training, manpower, system safety, nondestructive inspection, changes in the environment, mobility. Design interface parameters are expressed in operational terms rather than as inherent values.
8. Further guidance on PBL can be found in the DoD publication *Product Support: A Program Manager's Guide to Buying Performance*, Oct 01.

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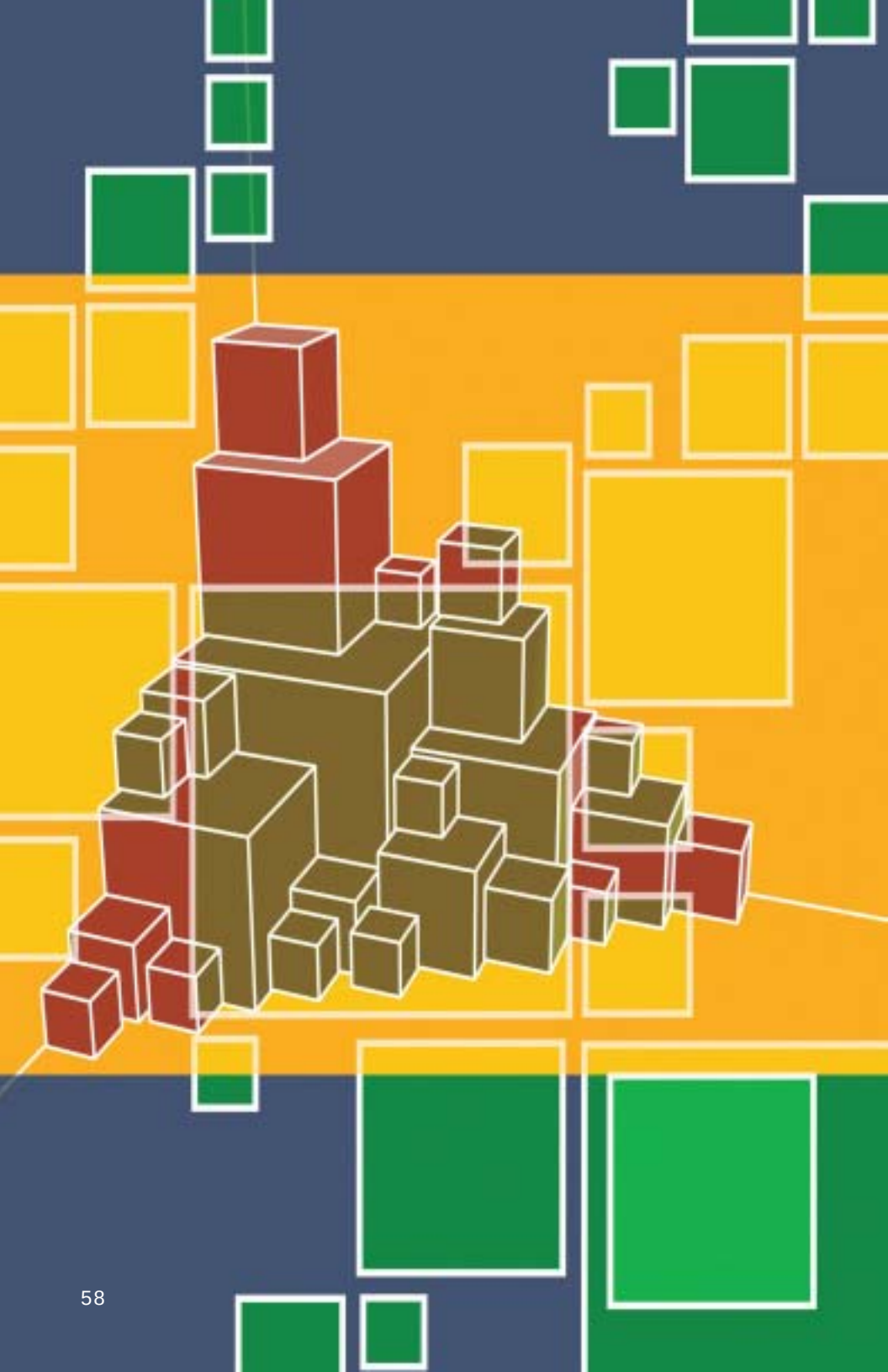
Technology (to include technological change and technological innovation) as a subject covers a lot of ground and often enjoins heated debate. It has proven to be one of the major tools for dealing with problems, more so in the last century than at any other time in history. However, critics of technology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

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

Notes

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



Does the Coalition Theater Logistics, Advanced Concept Demonstration Project Meet Multinational Logistics Data Sharing Requirements?

Vendor-Managed Inventory

A Building Block for Agile Combat Support

Agile Combat Support is an Air Force core competency focused on providing highly responsive worldwide force support.

Lieutenant Colonel Arnold H. Streland, USAF

Introduction

Successfully supporting worldwide Air Force contingency operations requires efficient and effective sustainment processes, such as those embodied in the Air Force core competency of Agile Combat Support (ACS). Applying proven, high-performance commercial sustainment models to Air Force needs is one way to improve combat support processes. This article discusses the commercial concept of vendor-managed inventory (VMI) and how it can contribute to making Agile Combat Support a reality for today's aerospace expeditionary force (AEF). It also defines the concept of VMI and explains how it differs from the traditional customer-vendor relationship. It includes an example of how VMI works in the commercial world and looks at how VMI fits with ongoing Air Force initiatives to improve the supply chain process, including examples of how VMI is being used in the Air Force. Primary aspects of electronic connectivity, a key enabler to any VMI program, is discussed, as well as important issues to consider when using VMI to help enable Agile Combat Support for the AEF.

Understanding the Concepts

Agile Combat Support is an Air Force core competency focused on providing highly responsive worldwide force support, with a small

A reactive approach has several problems.

forward-deployed footprint.[1] Vendor-managed inventory is a means of improving supply chain performance in which the vendor or supplier is responsible for maintaining the customer's inventory levels.[2] VMI is really a partnership, between the vendor and the customer, where the vendor takes responsibility for ensuring the customer's stock of product remains at certain prearranged levels.

Figure 1 shows how VMI differs from the traditional supply model. In the traditional model, the customer maintains inventory levels and issues purchase orders to suppliers when a product is needed. This is a reactive approach, rather than a proactive approach, to meeting customer requirements. A reactive approach has several problems. The customer may not consider vendor response time when placing an order, potentially resulting in late deliveries, which could negatively impact customer operations. Alternatively, the customer may maintain more stock than necessary because it does not know how quickly the vendor can respond. Maintaining more stock requires more floor space and costs more money. The VMI concept, on the other hand, ensures the vendor and customer are closely linked. The customer provides detailed usage data to the vendor, usually via electronic means. The vendor, in turn, then anticipates the needs of the customer and minimizes customer inventory levels, saving money and floor space, while ensuring availability of stock to the customer.

VMI Applied in the Commercial World

An example from the commercial world illustrates the VMI concept. The Stepan Chemical Company provides commodity chemicals, including surfactants (soaps), to the cosmetic industry. These chemicals are delivered by tank truck to the customer's facility. The typical order-delivery process requires the customer to place an order with Stepan when the customer determines the materiel is needed. This process often results in last-minute orders, leading to problems in arranging short-notice deliveries. Stepan implemented a VMI plan to minimize this problem at one customer location.[3] It installed an automated monitoring system on the customer's storage tank, which provided real-time inventory data. Stepan assumed responsibility for

monitoring the level of materiel in the customer's tank and making sure the customer had the materiel when needed. VMI allowed Stepan to anticipate customer needs by monitoring and maintaining inventory levels, ensuring sufficient stock without the need for excess inventory.

The result of this process was also a stronger customer-vendor relationship. Installing a tank monitor at Stephan's own expense showed the customer the vendor was dedicated to supporting it for the long haul. This is particularly valuable in commodity businesses where service and a penny-per-pound price difference might be all that separates one vendor from another. This is one VMI commercial success story.

VMI in the Air Force

The characteristics of VMI fit well with the objectives of Agile Combat Support. Agile Combat Support seeks to integrate information and transportation technology to increase the performance of the sustainment process, including reducing the overall footprint of forward-deployed support elements.[4] VMI uses electronic data interchange between the customer and vendor to track use rates, ensure proper inventory levels, and execute a variety of other transactions. As shown earlier, this type information exchange allows the customer to minimize the amount of inventory on hand. Minimizing inventory reduces costs and footprint of materiel. Reduction of costs and footprint is a key enabler under the ACS concept.

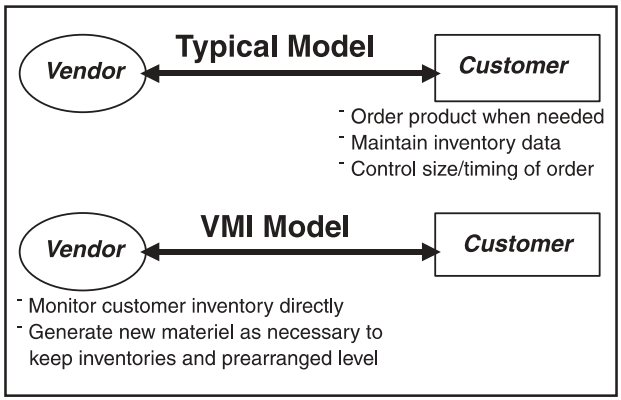


Figure 1. Typical Versus VMI Supply Chain Models

Vendor-Managed Inventory: A Building Block for Agile Combat Support

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Conclusion 68

There are important similarities between VMI and the Air Force Future *supply chain.*

The VMI model also fits well with ongoing Air Force supply chain initiatives. The Air Force defines the supply chain as, "The processes from the initial raw materials to the ultimate consumption of the finished product linking across supplier-user organizations."[5] Figure 2 shows the key thrusts of these initiatives are to increase weapon-system availability by shortening the length and improving the performance of the supply chain.[6] Compare the *Air Force Future* supply chain in Figure 2 to the VMI model in Figure 1. There are important similarities between VMI and the *Air Force Future* supply chain, including fewer steps in the process and close integration of customer and supplier.

VMI is one of several supply chain process improvement programs being implemented in the Department of Defense. Each of these programs uses electronic connectivity and commercial practices to improve the efficiency of the supply chain and reduce costs. Prime vendor (PV) is a Defense Logistics Agency (DLA) program that shifts inventory, inventory management, transportation, and personnel costs from the government to commercial firms.[7] This system essentially allows government agencies to purchase items the same way as their commercial counterparts. For example, airmen in a dining facility can now eat the same food available to local restaurants rather than being supplied through a distant defense depot.[8] Virtual prime vendor uses one source of supply for multiple items, thereby streamlining the number of transactions needed to obtain given items. The prime vendor and virtual prime vendor integrated with VMI provides several options to enhance Air Force supply chain performance through commercial practices and help make Agile Combat Support a reality.

VMI is being successfully applied in the Air Force today, even though the streamlined supply chain model is marked as *Air Force Future* in Figure 2. The Air Force contracts through the Defense Supply Center Philadelphia (DSCP) to participate in the Medical and Surgical VMI Program. The contract was awarded in the fall of 2001 and provides the Air Force guaranteed access to medical, surgical, and laboratory items at a fraction of the normal cost to purchase and store the materiel in defense depots.[9] The vendor

maintains 222 separate medical and surgical items. The Air Force contract supports day-to-day medical supply needs, as well as emergency delivery of critical items. The program guarantees supplies of critical *war stopper* items during military operations, up to and including two major regional conflicts. This high level of responsiveness is maintained through a strong partnership with DSCP, the vendor, and Air Force units with deployment requirements. The vendor and units work together to establish contingency supply requirements, and the medical and surgical VMI contract incorporates these specific unit-by-unit requirements. For example, under the current Air Force contract, the vendor is required to have all specified medical and surgical items, in the proper quantities, ready to support an AEF deployment within 8 hours of notification.[10] The Prime Vendor Surge Program, administered by the Defense Logistics Agency, provides timely delivery of the materials, covered under the medical and surgical VMI program, to units with early deployment requirements. Follow-on supplies and sustainment are normally received through theater logistics processes after the units deploy.[11]

The vendor is required to have all specified medical and surgical items, in the proper quantities, ready to support an AEF deployment within 8 hours of notification.

A successful customer-vendor partnership is critical for the success of VMI programs. The Air Force, through DSCP,

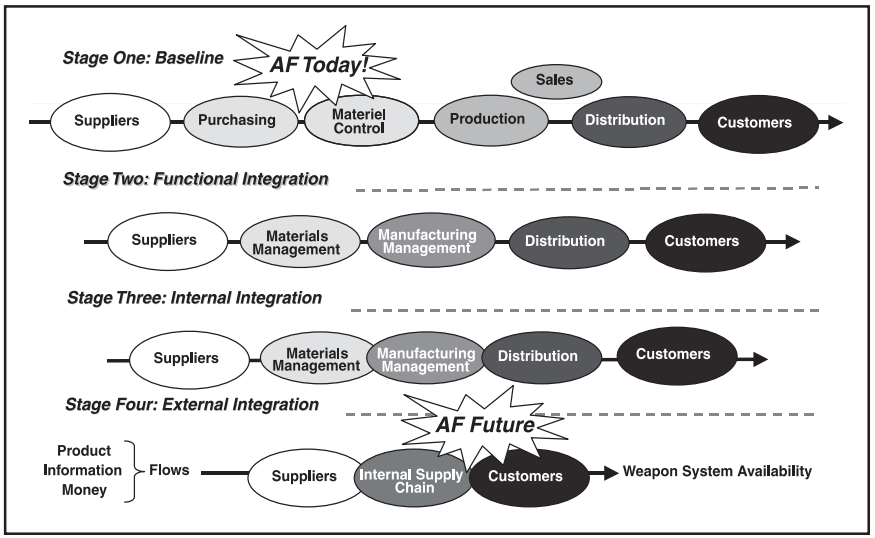

Figure 2. Air Force Supply Chain Initiatives[12]

A successful customer-vendor partnership is critical for the success of VMI programs.

established a relationship where it provided something positive to the vendor while saving money and guaranteeing access to critical supplies. The structure of the medical and surgical VMI contract makes this program a good deal for the government and for the vendor. The medical and surgical VMI contract administered for the Air Force by DSCP includes three components. First is the Service-owned inventory or government purchased materiel for which the vendor is paid the price of the materiel plus an annual inventory management fee to guarantee inventory rotation. The second component provides access to contractor inventory materiel (not government purchased) maintained and rotated within the contractor's normal commercial business based inventory levels. The contractor receives only an inventory management fee for this guaranteed access. The third and final component provides access to contractor-furnished materiel for which the contractor has increased its inventory levels to meet the government requirements.[13] This final component carries an inventory holding fee, plus an inventory management fee, to guarantee inventory availability, materiel freshness, and maximum stock rotation. The additional inventory holding fee for contractor-furnished materiel covers capital investment by the contractor to increase inventories. These fees are negotiated annually with the vendor based on commercial market conditions and military usage rates.[14] Note that this structure is cost-effective because the contractor has a strong commercial market for the same materiel. The commercial market allows the vendor the flexibility to rotate stock in a cost-effective manner, which helps keep costs down for the Air Force.

Prior to entering this program, the Air Force had to purchase large stocks of medical equipment and store it, awaiting a conflict. Many perishable items expired during long periods of storage and had to be restocked. The present DSCP VMI program allows the Air Force to purchase supplies only when needed, thus reducing inventory costs and stock footprints while ensuring fresh supplies. The program allows the Air Force to pay for guaranteed access to materiel rather than paying up front to keep large stocks in defense depots. For every dollar invested by the Air Force

in this program, it gains access to $7.54 worth of medical and surgical materials.[15] VMI for Air Force medical supplies shows that a commercial business concept can be adapted to support critical wartime needs.

VMI is also working in other parts of the Air Force. The Air Education and Training Command (AETC) implemented a VMI program for initial issue items given to all Air Force recruits. AETC realized substantial savings in cost and reduction in stock footprint from this effort. From 1996 to 1999, it reduced stock levels by 46 percent and reduced the financial investment in those stocks by 42 percent.[16] This was done while meeting a 29-percent increase in demand. Clearly, VMI is also working for AETC. While these are not critical war items, like the medical supplies previously discussed, the savings from such noncritical materiel programs can be applied to help more critical Air Force budget items.

VMI solutions can save the Air Force money while increasing the efficiency of the supply chain.

Supplies of critical aircraft maintenance items are also available through VMI programs. The Fastenal Company, for example, provides access to more than 10,000 aerospace fastener products, built to both military and national aerospace standards, through its VMI program.[17] The company provides a turnkey program, including personnel and information systems needed to execute the effort. A program such as this would likely not support a forward operating location, but it could provide cost savings at more established rear area facilities and depots. Clearly, VMI has a wide variety of applications within the Air Force. From initial recruit issue to war-stopper medical items, VMI solutions can save the Air Force money while increasing the efficiency of the supply chain.

Electronic Connectivity—A Key Enabler

Electronic connectivity between links of the supply chain, as noted earlier, is a key ingredient to Agile Combat Support, in general, and VMI, in particular. Effective electronic connectivity is one thing all VMI programs have in common, whether commercial or government efforts. Proactively working to address customer needs requires detailed knowledge of customer inventory levels and usage rates, which is usually best obtained electronically. Electronic Data Interchange (EDI) is the most common form

VMI solutions can save the Air Force money while increasing the efficiency of the supply chain.

of electronic connectivity. VMI solutions can save the Air Force money while increasing the efficiency of the supply chain., including tracking inventory and completing sales transactions. Most EDI systems use the Internet for connectivity between the vendor and the customer. EDI is used in a variety of government programs. The Army Air Force Exchange Service uses EDI to support several VMI programs.[18] The Air Force Materiel Command logistics centers also use EDI. An example of successful EDI use is the Warner-Robbins Air Logistics Center Propeller Systems Program for the C-130, P-3, and E2/C2 aircraft. The Defense Supply Center—Richmond established a virtual prime vendor program for these propeller systems in 1996.[19] While not exactly a VMI program, this program provides an example of effective integration between government and vendor information systems to improve supply chain performance. The vendor's EDI system connects them with Warner-Robbins and with the Naval Aviation Depot at Cherry Point, North Carolina. This connectivity is essential to ensure the success of the program. Computer and communications advances may lead to a broad variety of EDI follow-on systems in the future. Regardless of the system used, the key point to remember is that electronic connectivity is a key part of the VMI program's vendor-customer partnership. It is a key enabler for improved supply chain performance.

Issues to Consider

Making VMI work in the commercial world or in the Air Force requires careful consideration of key issues such as forecasting supply needs and transportation requirements and integrating electronic connectivity. Proper forecasting of logistics planning factors—such as quantity, need time, and delivery location—must be established just as they would for any logistics activity.[20] Air Force units must clearly articulate their requirements for effective force support, including the types of materiel needed, amount of materiel needed for day-to-day or contingency operations, and locations for delivery. The vendor needs this information to determine production, storage, and transportation capacities needed to meet Air Force requirements. The Medical and Surgical VMI Program

encourages each unit supported by the program to work directly with the vendor to properly establish requirements. The Medical and Surgical VMI Program itself is part of a larger medical supply program. Recall that the VMI surge requirement was only intended to address initial deployment requirements. VMI is intended to be the first step in a larger medical and surgical readiness program administered by DSCP. In the event of a sustained conflict, VMI provides the initial surge capability that allows time for DSCP's larger industry-wide surge program to be implemented.[21] Proactive planning and effective forecasting are essential to implement a VMI program successfully and integrate VMI as part of a larger logistics readiness effort.

Clear understanding of requirements and close coordination of transportation are critical to the success of the VMI process.

The Air Force and the vendor must also coordinate transportation requirements to deliver materiel on time. This is especially important in times of conflict when delivering materiel may require a tightly coordinated mix of government and commercial transportation. Clear understanding of requirements and close coordination of transportation are critical to the success of the VMI process. The Medical and Surgical VMI Program has detailed transportation plans that can be used to support contingencies around the world. During peacetime, the vendor delivers directly to the user organization. During contingency operations, direct delivery may continue, depending on the weight of the item and location of the unit. Most contingency operations require the vendor to ship the materiel directly to a consolidation and containerization point (CCP) in the continental United States.[22] There are two CCPs, one in New Cumberland, Pennsylvania, and one in San Joaquin, California. Selection of the CCP for delivery depends on the location of the vendor and the deployed unit. The US Transportation Command assumes responsibility for delivery following receipt at the CCP. This kind of detailed preplanning is essential to ensure the smooth flow of critical supplies to the respective units during a contingency operation. This process was effectively used to support Operation Desert Fox, Ulchi Focus Lens, and several humanitarian operations.[23] Close vendor and customer transportation coordination is vital to the success of any VMI program.

The VMI model closely tracks ongoing Air Force supply chain initiatives and can help make Agile Combat Support a reality.

Electronic connectivity is especially challenging when integrating commercial and government information systems that often span national boundaries. Government and commercial computer security rules are often in conflict. Standard security devices, such as computer firewalls, often become obstacles to the effective flow of information. International linkages present a further problem. The EDI standard message format is not used outside North America. This means international electronic transactions must often carry at least two format standards for each transaction.[24] There is also the classic problem of a limited communications bandwidth to overseas theaters of operation. Providing effective electronic connectivity for any VMI program requires careful consideration of the communications and computer resources.

Conclusion

The VMI model closely tracks ongoing Air Force supply chain initiatives and can help make Agile Combat Support a reality. Implementing VMI changes the relationship between the customer and vendor. The vendor, rather than the customer, assumes responsibility for managing inventory levels. Proactive vendor tracking of customer inventory allows the customer to reduce on-hand stock, thereby reducing costs and the footprint of stock. The VMI program creates a true partnership with benefits to both the vendor and the customer. The customer gets reduced inventory cost and footprint. The vendor gets a strong, usually long-term relationship with an important customer.

The VMI model is being applied in the Air Force today to ensure everything from war-stopper medical items to initial-issue uniform items for recruits is available when needed, without the need for large, expensive depot inventories. Established VMI programs have a documented record of savings for the government while maintaining necessary performance standards.

Making VMI work, however, still requires attention to traditional logistics planning factors (how much stuff, where, when), as well as coordination of commercial and government transportation resources and electronic connectivity. Logistics forecasting must be done up front in the VMI program to prevent problems downstream.

Transportation planning must also be done in advance to ensure coordination of the often-limited commercial and government transport assets. Electronic connectivity between the vendor and customer is a key enabler for a successful VMI program, but caution must be taken to ensure the right resources are available to make the system work.

Properly applied, VMI can ensure timely availability of key items while reducing the cost and storage footprint of these materials for the Air Force customer. VMI demonstrates that commercial practices can be effectively implemented, even in support of military-unique activities such as short-notice deployments and contingencies. The VMI model is clearly a building block for Agile Combat Support.

The VMI model is clearly a building block for Agile Combat Support.

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Notable Quotes

Martin van Crevald, Technology *and War*

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

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

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

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

Is there uniqueness to aircraft maintenance expertise that distinguishes it from other logistics disciplines?

Aircraft Does

Once you receive this PhD in Maintenance, what will that do for you?

Maintenance PhD

the Air Force Need It?

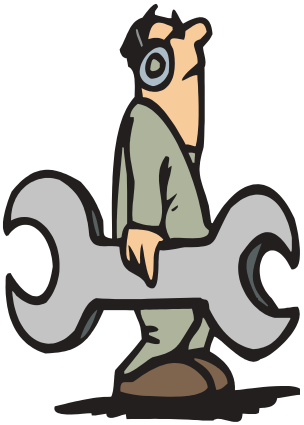
Do we need new schools, tougher schools, or longer schools to qualify for a PhD in Maintenance?

Lieutenant Colonel Charles L Webb III, USAF

Introduction

Why does the Air Force need officers with a PhD in Aircraft Maintenance? Aside from the fact the Chief of Staff of the Air Force thinks it is a great idea, there may be other reasons. Before the necessity of a PhD in Maintenance can be debated, the Air Force first needs to figure out, What is a PhD in Maintenance? Once you receive this PhD in Maintenance, what will that do for you? What things will be expected of you that were not expected of you previously? The next hurdle is to determine how to earn a PhD in Maintenance. There is no course catalog at *Maintenance University* describing the academic program that will qualify you for a PhD in Maintenance. With all the technical training, academic schools, advanced courses, professional conferences, how much is enough? What type of training or experience is required? Do we need new schools, tougher schools, or longer schools to qualify for a PhD in Maintenance? Will the existing maintenance officer career progression need to change to ensure the proper job experiences along the way? After answering these questions, we will be able to ask, Why a PhD in Maintenance? Why not a PhD in Logistics or Combat Support? What is so special about aircraft maintenance that it requires its own PhD? Is there uniqueness to aircraft maintenance expertise that distinguishes it from other logistics disciplines?

Aircraft Maintenance PhD: Does the Air Force Need It?



A PhD in Maintenance is not an advanced degree accredited by the Southern Association of Schools and Colleges

General John P. Jumper sees aircraft maintenance as a unique Air Force core competency, requiring a separate set of skills clearly distinguishable from other logistics career fields.[1] This article looks at defining the skills required for a PhD in Maintenance, how to earn a PhD in Maintenance, and finally, validating the need for this specific competency as opposed to the overarching skills of a logistics officer.

Defining a PhD in Maintenance

A PhD in Maintenance is not an advanced degree accredited by the Southern Association of Schools and Colleges. Officers who reach this lofty status will not be referred to as doctor. General Jumper coined this expression in 1998 when he was commander of the United States Air Forces in Europe. He was simply referring to an individual who was extremely well-versed in aircraft maintenance and in a position to use that experience. To best understand a definition of a PhD in Maintenance, we need to first take a look at Jumper's vision for a PhD in Maintenance. Next, we will see how aircraft maintenance as an Air Force core competency helps define a PhD in Maintenance. Finally, the skills required for an aircraft maintenance leader in the new combat wing organization will further define the concept of a PhD in Maintenance.

General Jumper's Vision for a PhD in Maintenance

General Jumper contends "flying and fixing our weapon systems are essential skill sets."[2] These are essential skills, and he believes they are the "two hardest things we do in the Air Force."[3] Therefore, ensuring these skills sets "requires PhD-level expertise, proficiency, and leadership."[4] The Air Force currently does not have a process to develop officers to obtain PhD-level experience in maintenance.

How the Air Force Currently Makes Maintenance Officers

After receiving initial training as an aircraft maintenance officer, the first several years are spent specifically in a maintenance job receiving further on-the-job training

(OJT) and experience. However, after the first assignment or two, maintenance officers are pulled away to *career broaden* into other logistics fields, such as supply or transportation. To stay in maintenance too long will make you a *stovepipe* maintenance officer, which would certainly be detrimental to your upward mobility. This makes perfect sense if the goal is to produce a logistics officer with experience in several logistics disciplines. However, if the vision is to create an individual with specific expertise in aircraft maintenance, the existing system fails.

New Vision for Maintenance Officers

General Jumper wants to produce a senior maintainer whom all the squadron maintenance officers can look up to as the expert maintainer. "I want that maintainer to be a colonel who, out of a 20- to 24-year career, has about 14 or 15 years of experience working directly on the flight line."[5] This description fits the profile of a deputy commander for maintenance found in the wing organization from 1978 to 1991. In fact, in describing his vision for a PhD in Maintenance, Jumper recalls his experiences with Colonel Tommy Richardson, a former deputy commander for maintenance.[6] Richardson was a dedicated maintenance officer who gave up the opportunity to attend a senior service school so he could continue to be a deputy commander for maintenance. He was rarely at his desk but could be found in his truck on the flight line. He had the ability to spot the slightest infractions of maintenance discipline and was quick to have the offender standing before his desk to explain his actions. Jumper says that is how he learned maintenance. He would find Richardson on the flight line, kick out the lieutenants who were riding along with him being mentored, and watch and listen to the master. That is the vision Jumper has for the senior maintainer holding a PhD in Maintenance. That is the maintainer he wants running the maintenance organizations of tomorrow. He wants all other maintainers to say, "I want to be that maintainer some day."

General Jumper also looks at aircraft maintenance from a new perspective, that of an Air Force core competency. This perspective helps frame the definition of a PhD in Maintenance.

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Maintenance as an Air Force Core Competency

It is clear aircraft maintenance does not standout as an all-important Air Force core competency in the current depiction of core competencies.

Air Force Doctrine Document, 1 September 1997, lists the Air Force core competencies: Air and Space Superiority, Global Attack, Rapid Global Mobility, Precision Engagement, Information Superiority, and Agile Combat Support (ACS). These competencies define what we do as an air force and are in direct support of our national military objectives. The Agile Combat Support competency contains the traditional logistics functions of supply, transportation, maintenance, contracting, and logistics plans, in addition to services, civil engineering, communications, medical and legal services, security, and personnel support functions. Seven core principles, six master processes, and 21 logistics tasks further distinguish Agile Combat Support. The actual elements of aircraft maintenance are found in several of these 21 tasks. It is clear aircraft maintenance does not standout as an all-important Air Force core competency in the current depiction of core competencies.

General Jumper's Declaration

To highlight the need for a PhD in Maintenance, General Jumper declared, "Maintenance of air and space weapons systems is a core competency of the United States Air Force."[7] He justified this assertion by pointing out the Air Force's aging aircraft fleet and the effects of years of resource shortfalls. Countering these two conditions will require "increased attention to the balance of sortie production and health of our fleets."[8] This is a new challenge for the maintainer. A much clearer focus and emphasis fall on maintenance to meet the mission. No longer will aircraft maintenance just be an aspect of logistics and the ACS concept, but it will stand alone and be accountable as an Air Force core competency. The challenge of maintaining aging aircraft and meeting the aircraft fleets' high operations tempo will rest on the backs of maintainers and their ability to use available resources. No longer will the operations group commander be responsible for sortie production with the logistics group commander responsible for the health of the fleet. One maintainer, a maintenance group commander, will take on the entire responsibility for aircraft maintenance. The Air Force needs a career maintainer with a PhD in Maintenance to lead this effort.

Air Staff Direction

The Air Staff's Director of Maintenance, Brigadier General Anne Harrell, further defines maintenance as an Air Force core competency with three specific maintenance core competencies—air and space weapon systems maintenance, maintenance management, and contingency operations.[9]

Air and Space Weapon Systems Maintenance. The number one job of a maintainer is to ensure the weapon systems are maintained correctly. This means the individuals with their hands on the aircraft have to be technically proficient to troubleshoot and perform the maintenance. In addition to the hands-on maintenance, the maintainer must be able to document the maintenance performed with clarity and accuracy. Proper supervision of these front-line maintainers is also inherent in this maintenance core competency to provide leadership and direction to the work force.

Maintenance Management. There are several management skills and positions throughout the maintenance complex that support the front-line maintainer. These skills comprise a separate maintenance core competency. Scheduling maintenance, gathering maintenance data, providing analysis, monitoring and reporting maintenance actions, and providing adequate training, and numerous other staff functions relating to managing the maintenance complex are essential to the safe production of sorties while maintaining the health of the fleet. These functions also serve as a valuable conduit of information to senior leaders.

Contingency Operations. By all accounts, contingency operations are here to stay. Producing sorties and maintaining a healthy fleet require a completely different set of skills in a contingency environment. Maintainers must not only have the mindset of working out of a suitcase but also know how to pack and what to pack in the suitcase. The art of packing out a maintenance unit used to fall to one or two individuals, who always did it and who, many times, were the only ones who could do it efficiently. These skills must now be shared with more and more maintainers. Aside from the physical packing out, the entire maintenance unit operates from a different perspective.

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Sortie durations may be different from home station, the flying window may vary from normal operations, support equipment may be shared and not be as easily accessible, and the expert for a specific maintenance repair may not be deployed. All these variables make for a new environment to operate within.

Maintenance core competencies help define what it is to hold a PhD in Maintenance.

Maintainers need to master these core competencies to meet the challenges ahead. Likewise, these maintenance core competencies help define what it is to hold a PhD in Maintenance.

New Skills Required in the Combat Wing Organization

General Jumper's vision for a PhD in Maintenance was put into place with the advent of the new combat wing organization. He feels the level of proficiency needed to meet the demands of the Air Force is only possible if we allow our leaders to develop great depth in their specific fields. "It is for this reason that we will transition into a new combat wing organization designed to fully develop commanders with specific functional expertise to fully plan and execute air and space power as part of expeditionary units."[10] Jumper originally outlined his plan to consolidate all maintenance under one colonel during the December 1999 United States Air Forces in Europe Senior Leaders Maintenance Course.[11] His vision will now take effect. The new combat wing organization will begin with initial operating capability 1 October 2002 and achieve full operational capability by 30 September 2003.[12] This organization establishes an operations group, a maintenance group, a mission support group, and a medical group. For the first time since 1991, all aircraft maintenance will be consolidated within one group, the maintenance group.

Maintenance Group Objectives

The objectives of the maintenance group can be rolled into three themes.[13] First, it must execute the full spectrum of base-level air and space weapon systems maintenance and generation. This is a function previously split between the operations and logistics groups. Next, it must produce combat-capable sorties at designated rates. This

demanding job was accomplished in the operations group under the leadership of an extremely experienced operator. Finally, the maintenance group must balance operational demands against long-term fleet health. This objective was also split between operations and logistics groups and looks to be the most difficult task of all. It is further defined with requirements to rapidly generate and recover air and space weapons and weapon systems, provide and sustain operational presence worldwide, and sustain home-station operations. This is where on-equipment and off-equipment maintenance come together, daily flying schedule and long-term fleet management merge, and home station and contingency operations are standardized.

Maintenance Group Commander Role

The maintenance group commander is expected to be the role model to maintainers just as the operations group commander is to the operators.[14] The specific responsibilities of the maintenance group commander are outlined in the recently revised Air Force Instruction (AFI) 21-101, *Aerospace Equipment Maintenance Management.* The commander is "responsible for aerospace equipment maintenance required to ensure balance between sortie production and fleet management."[15] The instruction goes on for six pages, describing the specific responsibilities of the maintenance group commander. Key responsibilities that help define a PhD in Maintenance focus on quality assurance, maintenance operations center, maintenance plans, scheduling and documentation, and wing weapons manager.

Quality Assurance. One of the pillars of aircraft maintenance is an effective quality assurance program. Previously, the wing's quality assurance program was divided between the operations and logistics groups. Now the maintenance group commander leads a combined quality assurance office. Senior maintenance leaders have not been exposed to a combined quality assurance office since 1991, and now they will be running one.

Maintenance Operations Center. The maintenance operations center used to be known as the eyes and ears of the deputy commander for maintenance but became a wing-level organization with the objective wing in 1991.

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The maintenance operations center will once again be a valuable tool for the maintenance group commander and represents a new area of required expertise

According to AFI 21-101, its charter is to "monitor and coordinate sortie production, maintenance production, and execution of the flying and maintenance schedules, and maintain visibility of fleet health indicators."[16] In the past, the significance of the maintenance operations center dwindled, as it became a mere subset of the command post. Now the maintenance operations center will once again be a valuable tool for the maintenance group commander and represents a new area of required expertise.

Maintenance Plans, Scheduling, and Documentation. This section now transfers from the operations group to the maintenance group. It is at the heart of balancing the daily flying schedule and the maintenance schedule, while focusing on the long-term health of the fleet. The maintenance plans, scheduling, and documentation section maintains historical maintenance data within the maintenance information system and uses this data to develop wing maintenance plans. Of particular importance is the management of the programmed depot maintenance that actually gives up possession of aircraft for extended off-station depot maintenance.

Wing Weapons Manager. Finally, the wing weapons manager moves from the operations group to working directly for the maintenance group commander. The responsibility for compliance, continuity, and standardization for all weapons loading and armament systems matters now rests in the maintenance group. The previous organization had the responsibility for weapons loading in the operations group, with armament systems in the logistics group.

The building blocks of the combat wing organization and maintenance group and role of the maintenance group commander are underlined by a *back to basics* maintenance philosophy outlined in the revised AFI 21-101, *Aerospace Equipment Maintenance Management*. The summary of changes in AFI 21-101 state, "The entire document reflects a *back to basics* compliance-oriented maintenance philosophy and supports the combat wing organization."[17] All combined, these new skills work together to provide a composite definition of a PhD in Maintenance. When added to General Jumper's vision of the PhD in Maintenance and role of maintenance as an Air Force core

competency, it is easy to picture a colonel taking on the full responsibility for maintenance and standing up a new maintenance group. The real challenge comes in determining how to grow such an individual.

Earning a PhD in Maintenance

The Air Force will almost have to start from scratch in laying out requirements for a PhD in Maintenance. Currently, after completing the Aircraft Maintenance Officer Course, the graduate is entitled to wear the Basic Aircraft Maintenance Badge. The Senior Aircraft Maintenance Badge results from 7 years' service in a logistics job. This is followed by the Master Aircraft Maintenance Badge upon completion of 15 years in a logistics job. These requirements were never intended to produce a maintainer worthy of a PhD in Maintenance. So what does it take to earn a PhD in Maintenance? When General Jumper revealed his plan for the combat wing organization, several maintenance leaders sprang into action to develop a systematic approach for obtaining a PhD in Maintenance. General Harrell's vision was, "Build a world-class maintenance officer training program, and you'll develop world class maintenance officers."[18] Her premise for this maintenance officer training would be to develop them as leaders and officers first; make them technically proficient; have them be managerially astute; direct them to be experts in flight-line, munitions, and support shop processes; and educate them to be sortie producers in garrison and deployed.

The Air Force must look specifically at current training and see how it might be altered to help build a PhD in Maintenance.

To accomplish this vision, the Air Force must look specifically at current training and see how it might be altered to help build a PhD in Maintenance. The Air Force should also explore new schools that may be better suited to produce a PhD in Maintenance. Finally, the career path that best supports a PhD in Maintenance is probably not the one currently in place, so a new path needs to be thought through and revised.

Current Training Available Supporting a PhD in Maintenance

The Aircraft Maintenance Officer Course (AMOC) and Munitions Maintenance Officer Course (MMOC) stand

The challenge is to better use these training opportunities to build the stepping stones for a PhD in Maintenance.

out as the starting block toward a PhD in Maintenance, but there are several courses previously viewed as optional that can help build the maintainer of the future. Most wings have a maintenance officer training program that acclimates the individual to the local environment and aircraft familiarization courses giving general systems information on the aircraft assigned to that particular wing. The Air Force Institute of Technology (AFIT) offers several logistics courses. The major commands have varying versions of the Senior Leaders Maintenance Course. There are numerous other courses focusing on maintenance skills that can help distinguish between a graduate-level and PhD-level maintainer. The challenge is to better use these training opportunities to build the stepping stones for a PhD in Maintenance.

AMOC/MMOC

For the maintenance officer, the 70-day AMOC is the only formal training currently required. Likewise, the munitions or missile maintenance officer is required to attend only the 40-day MMOC. Even though these are basic entry-level courses designed to provide a fundamental expertise, they do expand upon the overall logistics career fields. General Harrell's push is to "strengthen curriculum and get tough on content."[19] The primary concern is to stay focused on maintenance or munitions but not on all the logistics career fields. In the past, a maintainer had to career broaden into another logistics discipline (supply, transportation, or plans) to truly become a logistician. This produced a tendency to preview all logistics career fields at every opportunity, including the lowest levels, to someday produce a well-rounded logistician. The intent is to focus the AMOC/MMOC curriculum even further into "Combat Air Forces and Mobility Air Forces specific material, Total Force and EAF concepts, observation of several maintenance tasks, and shifted attention of munitions management from behind the fence to flight line needs."[20] This will allow more time for practical hands-on application for a specific type of weapon system.

Aside from revising the curriculum, General Harrell is attempting to change the negative perception of instructor duty. Her plan is to "put our best behind the podium."[21]

This requires commanders to push instructor duty, hire the best, and take care of them. These are all necessary ingredients to creating a premier training program.

Wing Maintenance Officer Training Programs

Most every flying wing has some sort of maintenance officer training program designed to give new maintainers an orientation. These programs can range from a couple of days to a couple of months and comprise merely a walking tour of the maintenance complex to hands-on operations of aerospace ground equipment. Since participation in this program precludes their primary job, they are sometimes seen as an expensive investment in training that could be better spent for on-the-job training. As a result, any orientation program is accomplished as quickly as possible, and the bulk of training comes about from the *fire hose* of day-to-day operations. This was often seen as the preferred solution since the Maintenance Officer Training Program was run at the squadron level in the logistics group and many of the students were in the operations group. With the combat wing organization, all maintenance officers will be in the maintenance group, giving the maintenance group commander the opportunity to shape the local training content and duration.

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Aircraft Familiarization Courses

Wing-level field training detachments offer aircraft familiarization for the particular weapon systems at each wing. These courses are optional and, as the Maintenance Officers Training Program, are an investment in time away from the primary duty. To prepare a maintainer for a PhD in Maintenance, these courses have to be strengthened and made mandatory. There is no substitute for firsthand knowledge of the weapon system, and the aircraft familiarization courses provide the foundation for this knowledge.

Air Force Institute of Technology

The AFIT School of Systems and Logistics, offers several formal courses helpful in achieving a PhD in Maintenance. Like the training opportunities mentioned, these courses

Most major commands have a senior leaders maintenance course originally designed to help those with little maintenance experience lead in a maintenance community.

are all optional. Courses range from Introduction to Logistics, Combat Logistics, and Strategic Logistics Management to the top-level Logistics Executive Development Seminar. Even though the primary focus of these courses is a broader logistics view, as opposed to specific maintenance expertise, they still teach advanced skills required for a PhD in Maintenance.

Senior Leaders Maintenance Course

Most major commands have a senior leaders maintenance course originally designed to help those with little maintenance experience lead in a maintenance community. As a result, the focus was not always on graduate-level skills but more foundational skills. General Harrell's initiative is to "baseline the Senior Leaders Maintenance Course for all MAJCOMs."[22] Doing this will establish a standardized expectation for senior leaders and provide a training opportunity to acquire those skills.

Additional Maintenance-Oriented Training

Training opportunities such as the Aircraft Mishap Investigation Course, Jet Engine Mishap Investigation Course, Weapons Safety Manager Course, Contingency Wartime Planning Course, and the Air Force Combat Ammunitions Center provide advanced skills in the maintenance arena. These courses are all optional. To earn a PhD in Maintenance, a combination of these courses will have to be mandatory. Each course provides a unique perspective on maintenance that builds a better maintenance officer and helps distinguish a graduate-level maintainer from the sought-after PhD-level maintainer.

New Training Opportunities

The requirement to develop a PhD in Maintenance cannot be met within the existing framework of formal training. To fill the gap, several new initiatives are being considered or are in the development stage. The Air Force Maintenance Advisory Group is considering the formulation of a program similar to what the operations community uses for advancement in proficiency. The approach centers on a building-block concept of

competencies. This will produce several new training opportunities to possibly include a *weapons school* type course for maintenance officers.

New OJT Structure

The core of maintenance training in the enlisted career fields centers on a thoroughly developed and documented OJT program. This is not the case for maintenance officer training. Most training would be classified as on-the-job training , but it is more experience-based or sometimes referred to as a *baptism by fire*. The maintenance officer does not have a detailed training record outlining everything required for upgrade or task qualification complete with start and finish dates like enlisted maintainers. As a result, the only criterion to be a fully qualified maintenance officer is a diploma from AMOC. There is no distinction between a 3-level, 5-level, 7-level, or 9-level for a maintenance officer. No one is advocating applying the same proficiency level system used by the enlisted force, but the operations community uses a proficiency-based system to distinguish experience.

The core of maintenance training in the enlisted career fields centers on a thoroughly developed and documented OJT program.

Operators' Perspective on OJT. Operators in a fighter squadron move up from wingman, to two-ship flight lead, to four-ship flight lead, to instructor rating based on experience and ability. Likewise, operators in an airlift squadron progress from copilot, to first pilot, to aircraft commander, to instructor pilot based on similar criteria. These programs are steeped in academics, ground testing, and flight evaluation. The training is thoroughly documented and monitored by senior leaders in the squadron.

Maintenance Officer Derivation on OJT. Maintainers can adapt the operators' style of qualification training to distinguish among experience-levels. New training initiatives are already in development to standardize OJT requirements for entry-level maintainers. Similarly, plans are in work to test entry-level maintainers on the fundamentals of AFI 21-101, *Aerospace Equipment Maintenance Management*; AFI 21-201, *Management and Maintenance of Nonnuclear Munitions*; and several related technical orders.[23]

A formal PhD-level course is still in consideration for maintainers in much the same format as the Weapons School for operators at Nellis AFB.

New Formal Training for Maintainers

The most visible new training initiative is the development of a maintenance intermediate course. This course will be mandatory for all maintainers during the 4- to 11-year period.[24] It would serve as a standard level of training for all maintainers and would fit the mold of the operations community's building-block-of-competency approach. Building a completely new course from scratch will take tremendous effort but underscores the need to develop a more defined maintenance officer proficiency certification process. According to the course developers:

> The course will fill a void in the existing maintenance officer training and education system by addressing key combat support functions and processes that, when fully understood, will allow the maintenance officer to successfully apply effects-based logistics in an expeditionary setting.[25]

A formal PhD-level course is still in consideration for maintainers in much the same format as the Weapons School for operators at Nellis AFB, Nevada. A Corona Fall 2000 tasking was to develop an integration plan to incorporate logistics officer training at the Weapons School. The intent is to create highly skilled operational logisticians competent in mobilization, deployment, beddown, sustainment, combat employment, redeployment, reconstitution, and command and control.[26] Since the original tasking, the Air Force has developed a new two-track system for logistics officers, made up of Aircraft, Munitions, and Missile Maintenance (21B) and Logistics Readiness (21R).[27] As a result, it is not clear which direction this course will go. Lieutenant General Michael Zettler, Deputy Chief of Staff for Installations and Logistics, wants to pursue a PhD-level course for logistics readiness officers but is still trying to determine if a requirement exists for a specialized PhD-level course for maintenance officers.[28] As it stands now, this would be a highly competitive, advanced program for a limited number of maintenance officers with less than 9 years in service.[29] This would help a few select younger officers work toward a PhD in Maintenance but would do little to prepare more senior officers who are thrust into the role of the maintenance group commander.

Career Progression

To produce a maintenance group commander who can fulfill the qualifications demands a career progression designed around *training*, *education*, and *experience*. The Chief of Staff Logistics Review Board of Advisors directed the establishment of training and experience *gates* for logistics officers. The objective would be to "strengthen accession, field, and follow-on training and develop a maintenance officer certification process."[30] The result is an evolving maintenance officer development (MOD) concept of operations (CONOPS) broken into three specific categories: entry, intermediate, and advanced.

To produce a maintenance group commander who can fulfill the qualifications demands a career progression designed around training, education, and experience.

Entry Level (0-3 years)

The road to a PhD in Maintenance begins with training. Graduation from AMOC or MMOC is the first phase of training, followed by a more thoroughly defined OJT program as previously outlined. Education required at the entry level is attendance at a wing-level aircraft familiarization course. The experience gate is a little harder to define. First, successfully complete 3 years in an aircraft, munitions, and missile maintenance core Air Force specialty code (AFSC). More specifically, spend at least 18 months in an aircraft maintenance flight, munitions section, repair shop, quality assurance branch, or wholesale logistics.

Intermediate Level (4-11 years)

The new Maintenance Intermediate Course highlights the training phase of the intermediate level. Attendance would be mandatory for all maintainers. Additionally, munitions maintenance officers must attend the Air Force Combat Ammunition Center course. Several options would be available for education at this level. The requirement is to complete three courses before the 11-year mark. Four specific AFIT logistics courses (032, 131, 262, 299), the Defense Acquisition University (DAU) Logistics Course, DAU Acquisitions Course, Aircraft Maintenance Investigation Course, Jet Engine Mishap Investigation Course, Weapon Safety Manager Course, or Contingency Wartime Planning Course qualify as one of the three required courses. Another option would be to obtain an AFIT graduate degree. The AFIT degree would satisfy all

Aircraft Maintenance PhD: Does the Air Force Need It?

Currently, there is no training requirement at the advanced level.

education requirements at the intermediate level. The requirements for experience at the intermediate level allow room for a special duty assignment or position outside the core AFSC. The goal is to successfully complete 6 years in a 21A or 21M position and, in addition, fill a position as a maintenance supervisor; lead an aircraft maintenance flight, munitions flight, or maintenance operations flight; work maintenance at an air logistics center; serve on a major command, numbered air force, or Air Staff; or teach as an AMOC or MMOC instructor. Until all the requirements for training, education, and experience are met at the intermediate level, you are not eligible to compete for squadron command.

Advanced Level (12- 15 years)

Currently, there is no training requirement at the advanced level. Education at the advanced level is reduced to completing one of the AFIT logistics courses (260, 399, 499) or one of the DAU logistics courses (203, 204, 205). Opportunities continue for special duty assignments with the requirement to have 9 years' experience in a core maintenance AFSC. In conjunction with the 9 years of experience, the requirement is to hold any two of the following positions: command and staff, depot and acquisition, joint logistics duty, deputy maintenance group commander, other logistics, or AMOC/MMOC instructor. You must also complete all these advanced level requirements to compete for a group-level command.

Documenting Progression

To provide the proper visibility into each officer's development, the Air Staff Maintenance Directorate is drafting a plan to implement a field maintenance officer development record. The purpose is to package a complete record of the officer's education and training history, provide a clear picture of the officer's background, and improve selection and placement for assignment.[31] The approval of the outlined MOD CONOPS will put the maintenance career field well on the way to showing the proper progression for obtaining a PhD in Maintenance. However, some may still wonder why we even need a PhD in Maintenance.

Validating a Need for a PhD in Maintenance Versus a PhD in Logistics

What is wrong with a logistics officer with a general knowledge of several logistics disciplines being in charge of maintenance? Has not this worked in the past? Validating the need for a PhD in Maintenance requires a closer look at what has changed. Is there something specific generating the change in thinking? The uniqueness of the maintenance career field, as well as the newly formed logistics readiness career field, provides support for two separate PhDs. Finally, the requirement for PhD-level maintainers above the wing level further validates the need for a PhD in Maintenance.

What Has Changed?

As the NMCM rate continues to increase, the Air Force must look for ways to get more out of each airframe.

Several trends are occurring in the Air Force today that give senior leaders concern. Leading the list of concerns are the effects of maintaining an aging fleet on combat readiness while sustaining a high operations tempo. As the nonmission capable for maintenance (NMCM) rate continues to increase, the Air Force must look for ways to get more out of each airframe. In addition, the long-term effects of the objective wing organization are becoming apparent in the quality of maintenance.

Effects of an Aging Fleet

Probably the strongest case for the concept of a PhD in Maintenance centers around maintaining an aging fleet. According to Air Force Statement 2002, the average aircraft age in the fleet was 17 years in 1991. This rate has steadily increased to 23 years in 2001. Based on future acquisitions, the Air Force is looking at an average fleet age of 24 years in 2006 and up to 28 years in 2016.[32] General Jumper asked the question, "If we are to continue to deal with aging weapon systems, are we growing the right kind of focused maintainer to deal with these problems?"[33] He would contend that the Air Force is not growing the proper maintainer who is capable of sustaining an aging fleet. The new wing organization, with the advent of the maintenance group, is his solution for developing a maintainer with a PhD in Maintenance. A steady decline in maintenance indicators over the last 10 years sparks the need for a

The objective wing came into existence in 1991, and by 1995, problems began to develop.

change. Total NMCM rates, a major leading indicator for fleet health, have increased from 7.6 percent in 1991 to 18.1 percent in 2001.[34] Complicating the effects of an aging fleet is the high operations tempo sustained throughout the Air Force. The calendar years are advancing on the aircraft fleet, and the actual airframe flying hours are accelerating well beyond the anticipated rates. This brings about a fleet comprised of *tired iron* and further validates the need for a PhD-level maintainer to manage the fleet.

Long-Term Effects of the Objective Wing

The objective wing came into existence in 1991, and by 1995, problems began to develop. In July 1995, the Air Combat Command (ACC) Commander, General Joseph W. Ralston, sent a letter to all ACC units describing some adverse maintenance trends.[35] He cited failure to use technical data, safety violations, overdue training, documentation errors, and scheduling issues as continuing problems. He said the number one explanation for the climate that might be wearing at the underpinnings of sound maintenance was the objective wing. He blamed the objective wing for deleting the central staff function that provided day-to-day oversight and guidance to maintenance organizations. "We no longer have the experienced colonel and maintenance staff which focused every day on the basic fundamentals and health of the fleet."[36]

General Jumper's Preobjective Wing Perspective. Jumper's experience as the 33rd Tactical Fighter Wing Commander—composed of the 58th, 59th, and 60th Tactical Fighter Squadrons—was before the objective wing reorganization and provided a storybook picture of the operations and maintenance relationship. The 58th Tactical Fighter Squadron was the first F-15 squadron to receive the new Pratt and Whitney–220—engines. The 59th was the first F-15 squadron to receive the new advanced APG-70 radar set. Jumper actually delivered aircraft 85-127, the first APG-70 radar-equipped aircraft, from the factory to the wing. Finally, the 60th was the first F-15 squadron to receive the highly improved avionics upgrade, multistaged improvement program aircraft. At the same time, aircraft maintenance unit officers in charge were briefing Jumper daily on maintenance indicators. Almost all maintenance

indicators were well above standard. Maintenance officers had the added benefit of briefing the deputy commander for maintenance daily before briefing the wing commander. All in all, Jumper's experience as a wing commander would be difficult to match in any objective wing after 1991.

Objective Wing Improvements. The Air Force attempted to improve the objective wing by assigning a lieutenant colonel maintenance officer as the deputy operations group commander for maintenance but had little effect on the negative trend in maintenance indicators. Later, the Air Force dictated that the wing commander receive a daily briefing focusing on specific operations and maintenance indicators. This, too, had little effect on the overall health of the fleet. The absence of a colonel with PhD-level experience and with complete responsibility for the maintenance community was too much to overcome. General Jumper is quick to point out, "Our operators have not flunked maintenance—we aren't fixing something that's broke, we are making it better."[37]

Uniqueness of a PhD in Maintenance

Singling out maintenance from the other logistics disciplines should in no way slight the significance of all other logistics career fields. According to Chief Master Sergeant John Drew, the senior maintainer working with the RAND Corporation on AEF strategic planning, the primary focus on maintenance came about because of a sense of urgency.[38] Improvements need to be made throughout the logistics arena to increase the efficiency of the AEF.

Singling out maintenance from the other logistics disciplines should in no way slight the significance of all other logistics career fields.

PhD in Maintenance, First Importance

Importance was placed first on improving aircraft maintenance because of the nature of the mission. There is no substitute for a broken airplane. It is not a matter of efficiency; it is a matter of go and no go. When the aircraft is broken, brute force will not fix it. There are possible workarounds that might lack efficiency when it comes to load planning, types of transportation, and establishing supply lines. Aircraft maintenance, on the other hand, is a unique capability with few shortcuts. For this reason, the urgency was placed on finding ways to maintain an aging

fleet while sustaining a high operations tempo. Without extra money for aircraft parts or manpower, realigning all maintenance under a single career maintainer was seen as the best option to improving the health of the fleet. Without a healthy fleet the AEF concept folds.

Operation Allied Force taught maintainers many lessons about deploying a healthy fleet.

Lessons from Operation Allied Force

Operation Allied Force taught maintainers many lessons about deploying a healthy fleet.[39] Several stories emerged about aircraft arriving in theater without sufficient phase hours to be useful. Likewise, there were several cases of aircraft arriving with overdue scheduled maintenance. These incidents, coupled with several accounts of not having the proper tools and equipment, led to questions concerning the capability to deploy and maintain a healthy fleet. General Jumper saw the effects of these problems first hand as commander of the United States Air Forces in Europe. He felt corrective action pointed to the need for a PhD-level maintainer in charge of sortie production as well as fleet health.

Why Not Both?

The necessity for a PhD in Maintenance does not preclude the necessity for a PhD in Logistics. In fact, Chief Drew believes the PhD in Logistics will be the next priority in improving the AEF.[40] General Zettler has already decided the Air Force needs a specialized PhD-level course for logistics readiness officers.[41] Plans are underway at the Air Staff to determine the courses required, identify target populations, and recommend a location. General Jumper has expressed his concern as well, "If the trends of the last decade continue to dictate that we deploy rapidly into tent cities on bare or ill-prepared bases, are we growing the kind of support personnel who understand all that is needed to pick up a unit, get it there, and sustain it?"[42]

The Fall Corona 2001 established a 1 November 2002 deadline for combining the logistics plans, supply, and transportation career fields into a newly developed logistics readiness career field.[43] These logistics readiness officers will be an integral part of the mission support group in the new combat wing organization. This group has the overwhelming responsibility for merging force

protection, load planning, communications, intransit visibility, reception, contracting, bare base, munitions and fuels site planning, personnel readiness, and contingency beddown. General Jumper realizes, "We are just beginning to develop this skill set."[44] The skills of a logistics readiness officer are unique and demanding in their own right without adding the weight of maintenance. Likewise, the career progression to best build a mission support group commander will put increased demands on the logistics readiness officers, further validating the need for both a PhD in Maintenance and a PhD in Logistics.

PhD in Maintenance Skills Required Outside the Wing

The focus on a PhD in Maintenance has centered on the need for a single expert maintainer responsible for the entire maintenance community at the wing level.

The focus on a PhD in Maintenance has centered on the need for a single expert maintainer responsible for the entire maintenance community at the wing level. However, the demand for a PhD in Maintenance does not stop at the wing, air logistics centers, and major commands, and the Air and Joint Staff all require the expertise of a maintainer with a PhD in Maintenance.

Air Logistics Centers and Product Centers

In 2002, for the first time, senior materiel management positions in the Air Force Materiel Command were boarded with the Air Force Command Selection Board. The board that selects the next group and wing commander candidates now also selects the materiel leader group and materiel leader wing candidates. These positions are critical to the leadership of the air logistics centers and product centers and are considered group and wing commander equivalents. Currently, there are approximately 50 positions that require specific PhD-level maintenance experience.[45]

Major Command Headquarters

Likewise, major command headquarters have requirements for career maintainers. Each major command staff has a maintenance directorate distinguished from the other logistics disciplines. In the past, these positions were filled by logisticians with significant maintenance experience, but the existing career progression could not produce what was actually preferred—a PhD-level

maintainer. The Air Force has more than 30 positions best suited for career maintainers.[46]

Air and Joint Staffs

As is the case with major command headquarters, the Air Staff and the Joint Staff have specific positions for maintenance-experienced individuals. These positions total approximately ten slots.[47] All officers assigned in these positions certainly have maintenance experience, but the existing system did not allow them to spend their entire career in the maintenance field. That will now change. In addition to the policy positions in the maintenance directorate, several other positions throughout the Air and Joint Staff require PhD-level maintenance expertise. Programming and budget, as well as policy, will now benefit from a career maintainer on the staff.

As is the case with major command headquarters, the Air Staff and the Joint Staff have specific positions for maintenance-experienced individuals.

Summary

So what has brought on the necessity for a PhD in Maintenance? Certainly General Jumper's vision of the Air Force and combat wing organization plays into the need. Creating a wing structure with an entire group dedicated to sortie production and fleet health takes the Air Force back to a time when maintainers were strictly maintainers and not broad logisticians. In addition, Jumper now distinguishes aircraft maintenance as an Air Force core competency. He makes the distinction between aircraft maintenance and the other logistics disciplines that comprise the Agile Combat Support concept. To further establish aircraft maintenance as an Air Force core competency and ensure the capabilities exist to support this competency, the Air Staff Director of Maintenance outlined the three maintenance core competencies of air and space weapon systems maintenance, maintenance management, and contingency operations. These competencies can be obtained more readily in the new combat wing organization. Aligning all maintenance under the new maintenance group and giving the commander the added tools of quality assurance, maintenance operations center, maintenance plans scheduling, and documentation, along with the wing weapons manager help ensure the Air Force maintenance core competency. Likewise, these ideas

work together to define just what it means to have a PhD in Maintenance.

Earning a PhD in Maintenance requires a new look at how we train maintainers. Current training needs to focus more on aircraft-specific application, while many courses viewed previously as optional need to have more emphasis. New training is also required to ensure the Air Force can produce a maintainer with a PhD in Maintenance. Formalizing OJT and the development of a maintenance intermediate course will move the Air Force in the right direction. Finally, a structured and documented career progression for maintainers with specific requirements on experience, training, and education will put the necessary skills in the hands of future maintenance leaders.

Validating the need for a PhD in Maintenance over the need for a PhD in Logistics may meet with resistance at first. Maintenance received importance over other logistics disciplines because of the Air Force's aging fleet and high operations tempo. Maintaining a balance of sortie production, while ensuring the health of the fleet, has become the greatest logistical challenge. Based on his experience before and during the objective wing years, General Jumper's solution lies in the combat wing organization with a PhD-level maintainer leading both efforts. The final answer does not lie solely within aircraft maintenance. Plans to develop a PhD-level logistics readiness officer are already in work. The uniqueness of a PhD in Maintenance in no way slights the significance of other logistics disciplines. Only a critical sense of urgency placed the PhD in Maintenance as a priority above other logistic competencies. The wing will not be the only organization to benefit from maintainers with a PhD in Maintenance. Air logistics centers, product centers, MAJCOM headquarters, and the Air and Joint Staffs all have positions requiring PhD-level maintainers. Up until now, these positions were filled with logisticians with some maintenance experience. Now the effects of a career maintainer will reach into policy, programming, and budgeting at all levels of the Air Force.

Air logistics centers, product centers, MAJCOM headquarters, and the Air and Joint Staffs all have positions requiring PhD-level maintainers.

Has the time come for the pendulum to swing back toward the specialist's perspective? With down sizing, lower budgets, and a move toward becoming generalists,

some things proceed with little difficulty—but not in aircraft maintenance. With the aging fleet and increased reliance on airpower, aircraft maintenance is one area where the Air Force needs the PhD in charge.

With the aging fleet and increased reliance on airpower, aircraft maintenance is one area where the Air Force needs the PhD in charge.

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The munitions industrial base is a relatively small but critical component of the ACS concept.

Munitions Industrial Base
What Can We Do About It?

Lieutenant Colonel Charles L Webb III, USAF

Munitions is only one segment of the industrial base but demands immediate attention to ensure the force is ready.

In the budget world, most people think if you throw enough money at a problem it will go away. After years of neglect, the munitions industrial base is one area where simply *throwing money* at it will not be enough.

The munitions industrial base is a relatively small but critical component of the Agile Combat Support (ACS) concept. The ACS concept is formulated around seven core principles designed to "create a combat support force that is highly flexible and able to respond to the specific needs of the combatant commander."[1] Six master processes and 21 logistics tasks further define the concept. One of these logistics tasks is the industrial base, which is assigned to integrate the capabilities of industry to improve supplier performance and accountability.[2] Munitions is only one segment of the industrial base but demands immediate attention to ensure the force is ready.

Overview

Since the close of the Cold War, procurement of ammunition funding has dropped significantly. With less funding spread across the munitions industrial base, this led to a diminishing contractor base. With the sudden insurgence in munitions funding following recent incidents, the munitions industrial base is struggling to meet the higher

The Air Force ended the Cold War with a substantial stockpile of conventional weapons.

production demands in a timely manner. Solutions to the dilemma are numerous and complex, but the following two approaches will help the struggling munitions industrial base. First, multiple-year contracting, as opposed to the normal single-year contract, can bring stability to the production capability and workforce. Second, changing the perspective on advocating funding from strictly a requirements-driven approach to an industry-based approach will ensure an adequate contractor base well into the future.

What Happened to the Munitions Industrial Base?

The Air Force ended the Cold War with a substantial stockpile of conventional weapons. As programs were cut to pay for the ensuing *peace dividend*, the Air Force severely cut procurement of ammunition. This situation naturally led to the shrinking of the contractor base, which compounds the problem now faced—too much money flooding the industry, literally choking the munitions industrial base.

Procurement of Ammunition Funding

Procurement of ammunition funding suffered through a steady decline from the end of the Cold War until just recently. Funding in the mid-1980s averaged about $750M, while funding in the mid-1990s bottomed out at about $300M.[3] With large war reserve materiel (WRM) stockpiles of munitions from the Cold War, the necessary test and training munitions were no longer procured, rather the WRM munitions were used for testing and training. This led to a decreasing stockpile of WRM with very little funding for replenishment. Funding for procurement of ammunition continued to drop until the shortfall for WRM and test and training munitions reached $2B in fiscal year (FY) 2001.[4] With Congress having not thought of threat of a major war, finding adequate funding for WRM was difficult. However, through intense advocacy by the Procurement of Ammunition Appropriation Managers and Headquarters Air Force Requirements Directorate, test and training munitions began receiving increased funding in the FY01 President's budget. Through supplemental

funding in FY01, $73M was added to the Procurement of Ammunition appropriation for test and training munitions.[5] Likewise, in FY02, $182M supplemental funding was appropriated for test and training munitions.[6] By February 2002, when the FY03 President's budget was submitted, test and training munitions were fully funded. The budget for procurement of ammunition went from President William Clinton's projected FY02 budget of $654M to President George Bush's FY03 budget of $1.1B.[7] Even though this funding was desperately needed to replenish the munitions stockpile, it was too late to save the munitions industrial base.

Diminishing Contractor Base

With a decade of decreased funding for ammunition procurement, there was no way for all the munitions contractors to stay in business. Most contractors in the munitions industrial base had only defense contracts to compete for with severely limited civilian application. Bomb bodies, flares, and fuses are a few of the munitions industrial base sectors hit the hardest. For example, since 1992, there has been a sole source for forged steel bomb bodies used in the Mk-80 series bombs.[8] This not only eliminates competition and any attempt to reduce unit costs but also limits the production capability to one manufacturer. There is also the threat of a single incident (safety, tornado, or even terrorist) completely stopping bomb body production. In similar fashion, the magnesium-Teflon flare industry is currently down to one supplier. A second vendor is going through requalification after having its production line shut down for more than a year following the third incident in 2 years. The last accident was significant enough to involve a fatality. The flare production process is an intricate and highly dangerous procedure, which has resulted in several mishaps with all the vendors involved. These circumstances have led to substantial backlogs in flare production and a 40-percent increase in unit costs. Likewise, fuse vendors dropped from 32 in 1987 to only 8 today.[9] As a result, it is difficult to find vendors capable of producing more technologically advanced fuses. Production of the new joint programmable fuse has been delayed more than 2 years because of technical deficiencies with the vendor. The Air Force is

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Munitions Industrial Base: What Can We Do About It?

TNT has not been produced in this country since 1986.

seeking its third vendor in an effort to find someone to produce a joint programmable fuse capable of working in all required parameters.

Several other commodities have been challenged with the diminishing contractor base. There is only one vendor producing laser-guided bomb (LGB) tail kits and guidance control units. These components are attached to the general-purpose bomb body to make a complete LGB, giving the bomb precision capability. A second vendor has been attempting to qualify for more than 2 years now but has yet to produce an LGB for the Air Force.[10] The preferred munition going into Operation Enduring Freedom was the joint direct attack munition (JDAM). Like the LGB, the JDAM uses a general-purpose bomb body but attaches a GPS-guided tail kit to provide a near-precision capability. These tail kits also are produced by a single vendor, which had an extremely limited production capability going into Operation Enduring Freedom. Probably the most devastating predicament to the munitions industrial base is in the production of trinitrotoluene or TNT, which is the major component of the explosive fill used in Air Force bombs. TNT has not been produced in this country since 1986, and the stockpile will be exhausted completely after filling the bombs from the FY01 buy.[11] Even more discouraging, with the many environmental constraints to production of TNT, there may not be a vendor in the United States. That leaves us with the options of reclaiming TNT from bombs currently awaiting demilitarization or buying it from an overseas source. There are problems inherent with both options. There is obviously a limited supply of TNT available to reclaim. Plus, the Air Force Research Laboratory still needs to approve the TNT reclaim process. The other option, purchasing TNT overseas, has political ramifications with identifying a weakness in the production capability to the world and relying on a foreign source for something as critical as an explosive fill for bombs. These considerations make it even more critical to develop a production capability in the United States.

The overall diminishing contractor base limits production capability, decreases competition, increases unit cost, and leaves virtually no surge capability. These observations were proven all too true with the wave of munitions funding in the FY03 President's budget.

Current Dilemma

For the last 5 years, the procurement of ammunition appropriation has averaged $570M a year.[12] The next 5 years forecast an average of $1.05B, almost doubling the previous 5 years. With the current budget process, the only quantities that can be purchased are what the contractor can produce in a 12-month period. In theory, the quantities the contractor produces in the 13th and subsequent months should actually be funded in the next year's budget. As a result, the money for anything of more than a 12-month production capability is actually needed next year, not now, so the money disappears. Increasing the contractor's 12-month production capability takes money to *facilitize*. This is a risky business for the contractor because there is no guarantee beyond the current year's funding. If the Air Force decides to use its own money to *facilitize* a vendor, it limits competition between vendors in the outyears. The Air Force recently chose this option with the JDAM. As the preferred munition in Operation Enduring Freedom, hampered with severely limited production, the Air Force spent $47M to enhance the Boeing facility used to make JDAM tail kits. In addition, the Air Force programmed more than $1B for JDAM production over the next 5 years.[13] Even with this concerted effort on a priority munition, JDAM tail-kit production will not meet the target production rate until August 2004—almost 3 years from the start of Operation Enduring Freedom. So we have to ask ourselves, is Agile Combat Support working? Are we readying the force? How do we best execute this sudden influx of money to the munitions industrial base?

If the Air Force decides to use its own money to facilitize *a vendor, it limits competition between vendors in the outyears.*

Is There a Better Way?

Munitions industrial base leaders agree on one short-term solution to stabilize the base. They have told the Air Force to change its contracting strategy. However, this change alone will not be enough, but with a new look at advocating funding for munitions, coupled with the change in contracting strategy, the Air Force can stabilize the munitions industrial base and ready the force.

Change the Contracting Strategy

The contracting strategy for munitions has traditionally been to solicit bids for a single-year contract. Sometimes,

Strategy does not allow for the contractor to plan beyond a single year.

the contract would have option years attached to the contract, but the only guarantee to the contractor was for the single year. This strategy does not allow for the contractor to plan beyond a single year. Full two-shift production in the plant one year may be followed with severe layoffs and only a half-shift of production the next or, worse yet, no production at all. This leads to difficulty in maintaining a fully trained, stable workforce. Likewise, there is no incentive to upgrade facilities to improve production capability with no guarantee for the next year. To alleviate this situation, senior leaders in the munitions industry presented their recommendations to the Air Armament Summit in March 2002. The continuing theme throughout the summit was clear: to stabilize the munitions industrial base, the current contracting strategy must be changed to one that incorporates a multiple-year contract.[14] This would offer the contractor several distinct advantages. The contractor could plan for production beyond the first year, procure long lead-time items, purchase bits and pieces in bulk for reduced costs, better use a fully trained workforce, and actually lower unit costs to the government.

Taking a look at bomb body production, from start to finish, it takes an average of 25 months to receive a bomb.[15] The contract allows the vendor 12 months to obtain the materials to produce the bombs before the manufacturing process begins. The bulk of this time is consumed with the procurement of steel. Since the company only is assured of the single-year contract, it only buys steel for that particular year. Those months in the production lead time must be absorbed each year, and without purchasing additional steel, there is no surge capability. By using a multiple-year contract and advance procuring steel, the contractor could reduce long production lead times and provide a surge capability currently nonexistent. The flare community would particularly welcome the stability to the workforce. In such a hazardous environment, a fully trained, experienced workforce would lead to a safer production line. This would allow the contractor to increase production capability and reduce the current backlog. In the case of the TNT shortfall, a multiple-year contract may be the only way TNT can be purchased from a US vendor. As mentioned earlier, a single-year contract offers little

incentive to *facilitize* production capability. Estimates from industry to develop a production capability for TNT range anywhere from $15M to $35M.[16] However, there is no way any company would invest this amount of money with only a single-year guarantee for production. With a multiple-year contract, a company could spread the up-front investment costs across the total length of the contract and provide an acceptable unit cost to the government with a profit margin worth the investment. Without the multiple-year contract, reclaimed TNT must be used, or TNT must be purchased overseas.

There are, of course, drawbacks to a multiple-year contract, the major one being it puts the risk on the government. If the agreed-upon minimum quantities are not purchased in each year of the contract, the government will pay substantial penalties for breaking the contract. In a world of changing funding priorities, no one has wanted to take that risk. In the Air Force corporate structure, if higher funding priorities arise, the remaining programs absorb the cut in funding. If a program is supported with a multiple-year contract, the Air Force corporate structure would be less likely to take money from that program because of financial penalties involved. This would lead to larger cuts in other programs and, in effect, surrender some of the Air Force corporate structure's flexibility. However, in light of recent events, it seems more certain than ever the Air Force will need munitions to meet its political objectives and the munitions funding line will remain stable. Now would be the time to take industry up on its recommendation and pursue a multiple-year contracting strategy.

If a program is supported with a multiple-year contract, the Air Force corporate structure would be less likely to take money from that program because of the financial penalties involved.

New Look at Advocating Funding

Procurement of ammunition funding is driven by requirements. Each year, the Air Staff's Requirements Directorate receives inputs from the combatant commanders and major commands. These inputs go into a model that develops the Nonnuclear Conventional Ammunition Analysis report, which establishes the munitions requirement each year. With this validated requirement, advocacy begins for funding. Like most programs, the requirements are not completely funded, so a prioritized funding list goes forward. The only

The munitions industrial base has been neglected for several years now.

consideration to the munitions industrial base is whether or not industry can support that year's buy, not what should be bought to keep the production line open. Industry provides a minimum sustainable rate for each commodity, but that minimum quantity is used only to determine the minimum amount required to buy *if* that particular commodity is going to be bought. Many times, the Air Force chooses not to buy a particular commodity in a given year. To provide stability to the munitions industrial base, the minimum quantity for each required commodity should be bought to ensure the production capability remains intact. The Air Force must look beyond the immediate operational requirement and purchase the minimum quantity required to sustain the munitions industrial base. The bulk of funding cannot be put in one particular preferred munition at the neglect of others and there be a contractor ready to support Air Force needs a year or two later. The Air Force needs to work with industry to validate the minimum quantity required to keep production lines warm and negotiate an affordable arrangement. Too many times when an attempt is made to procure a munition currently out of production, but with a valid requirement, the production capability no longer exists. This is particularly true with the volatile flare community. Finding a vendor to revive that capability is expensive and time-consuming. An industry-based approach to advocating funding will ensure the production capability remains for all required commodities in the munitions industrial base. Without this approach, only preferred and highly visible munitions will continue to receive funding with no guarantee of the other, equally as important, commodities maintaining a production capability.

Conclusion

The munitions industrial base has been neglected for several years now. Inadequate funding has led to a diminishing contractor base. When a strong industrial base was needed to pull the Air Force through in recent events, it found limited capacity with an even less surge capability. With a change in contracting strategy toward multiple-year contracting, the munitions industrial base

can stabilize its workforce and increase production. The funding to do this can come with a new look at advocating munitions funding. If the Air Force moves past the traditional requirements-based funding and looks toward an industry-based approach where it continually purchases commodities at the negotiated minimum sustainable rates for industry, it can ensure a strong munitions industrial base.

One of the six master processes of the Agile Combat Support concept is to *ready the force*. If the Air Force does not take the steps necessary to stabilize the munitions industrial base, Agile Combat Support will fail in its requirement to *ready the force,* and logisticians will have failed.

If the Air Force does not take the steps necessary to stabilize the munitions industrial base, Agile Combat Support will fail in its requirement to ready the force.

Notes

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Logistics is an absolute necessity for the success of any military mission.

The Logistics Officer and Agile Combat Support

Lieutenant Colonel Penny H. Bailey, USAF

Research and development, contracting, and acquisition officers, all part of the logistics group, are the ones who worked tirelessly in acquiring the state-of-the-art aircraft

Logistics is not inherently glamorous.[1] Commercials, promotions, movies, and so on are not made about logistics; they are made about the fighter pilot in a state-of-the-art aircraft, dropping bombs on target. However, logistics is an absolute necessity for the success of any military mission. Picture the fighter pilot without logistics. The pilot is sitting on the runway in a beautiful new jet with the best technology available. However, the pilot cannot get off the ground because there is no fuel to fly, no oxygen to breathe, no hydraulic fluid for the aircraft, and no munitions to drop—these are supplied through the logistics system. But before we can even get to this point, the flight suit and helmet the pilot is wearing are all part of the supply system, which is a part of logistics; therefore, those items are not available either. Wait, did I say the pilot was in a beautiful, high-tech aircraft? That is not possible either, because research and development, contracting, and acquisition officers, all part of the logistics group, are the ones who worked tirelessly in acquiring the state-of-the-art aircraft, so the pilot does not even have an airplane to fly. Additionally, the runway the pilot is now standing on is not possible either, because the civil engineers developed and built it, and they are part of the logistics career field as well. Now, we have a highly trained and well-paid pilot standing alone in an empty field. So how is the commercial or movie possible without the

Lessons concerning logistics have been learned and relearned.

logistics officer? It is not. Though it may not be glamorous, logistics is as crucial to the mission as the operator is to the weapon system.

Though not glamorous, logistics is vital to America's defense, and it is the foundation of combat power.[2] Lessons from previous conflicts have shown this to be true for any military conflict. Therefore, this article includes a review of logistics and training for the logistics officer and a short discussion of potential conflicts.

History

If one studies history, it becomes obvious lessons concerning logistics have been learned and relearned. As far back as Sun Tzu, the importance of sustaining an army has been stressed. In his work *On War*, Sun Tzu states, "An army which lacks heavy equipment, fodder, food, and stores will be lost."[3] This is logistics; it ensures the right equipment and supplies are at the right place at the right time. Logistics allows the warfighters to accomplish their jobs and win the war. However, in the Vietnam War, once again, America's forces had to relearn the significance of logistics. One example occurred in the first months of the conflict, when the 173[d] Airborne Brigade received *push* packages that had been developed and tailored based on World War II and the Korean conflict. When the troops arrived at the Tan Son Nhut Airport to secure the area, they found they were using ammunition at a faster rate than the packages were designed to support. Additionally, some of the ammunition was for weapon systems that had been retired from the inventory. Emergency requisitions were made and received for more than 225 tons of ammunition before the airport could be secured. The operation used every transport aircraft available in the theater for 7 days.[4]

Again, in the Gulf War, America found itself putting *tooth before tail* (operations before logistics). It took Iraqi forces less than 24 hours to secure their invasion of Kuwait. The world was uncertain whether Iraq would stop at Kuwait or try to move into Saudi Arabia. America immediately sent the warfighter overseas but sent no logistics support or sustainment cargo. Fortunately, Iraq did not progress into Saudi Arabia, and the commander of Central Command, General Norman H. Schwarzkopf, who had studied military

history, knew the significance of logistics. He was afforded the luxury of almost 6 months in which to build up logistical support, and large quantities of supplies and equipment were sent to the Middle East prior to taking any further military action.[5]

However, America's more recent conflicts have not been on a large scale. And it is this type conflict for which the Air Force needs to prepare. America has entered a time of change—in adversaries, force structure, force projection, and technology. To adjust to these changes, Joint Vision 2020 highlights five operational concepts with *Focused Logistics* being one of them. The Air Force has responded to *Focused Logistics* with Agile Combat Support (ACS), which establishes the role of logistics and combat support. Agile Combat Support will redesign the Air Force's support system into a more mobile, technologically superior, robust, responsive, flexible system, fully integrated with operations.[6]

Operations like those in Panama, Grenada, Bosnia, and Afghanistan are examples of agile combat. These are seemingly smaller, in-and-out operations that cannot afford a large logistics footprint or a long lead time for buildup. Who is going to engineer new logistics support for agile combat? Who needs to be properly trained to develop plans in support of this new type of conflict? Who will be expected to ensure the right equipment is at the right place, at the right time, in sufficient quantities? Of course, it will be the logistics officer. But how are the logistics officers going to be able to do this? Other than initial training in their functional area, there is no further logistics training, no broad logistical instruction.

Logistics Careers

To understand what logistics officers can provide to the warfighting commander, a detailed look should be made of the specific career fields. The Air Force has combined a number of careers into one area called operations support, sometimes referred to as mission support. In this area, there are 17 career fields. There is the *Officer Career Path Guide* for each career field available online at the Officer Assignments home page.[7] This guide is supposed to provide specific information of what is expected of the Air

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It is interesting to note the overwhelming requirement is for the officer to have a depth of knowledge.

Force officer in each career field and what the officers can expect to accomplish in their career. Figure 1 provides this information in an easy-to-read and comparative format.

The career fields are listed on the left in the figure. The competencies found in the *Career Path Guide* are listed across the top. The figures in the blocks are the number of times competency was mentioned as a requirement for that career field. The Opportunity/Goal on the far right is what the guide mentions as a possible position or the highest level one can attain at the end of a career. However, further research showed there are some positions the officer can obtain, which were not mentioned in the *Career Path Guide*. These opportunities or jobs are indicated in parentheses. Also, I have provided the present rank of the officer in the highest position mentioned.

After reviewing the information, it is interesting to note the overwhelming requirement is for the officer to have a depth of knowledge—to know a significant amount of technical information. The second most desirable competency is breadth of knowledge—knowing other areas within a specific career field. Experience or ability, the ability to apply technical knowledge to a specific job, came in as the third most desirable competency. It is significant to note the breadth of knowledge referred to in the *Career Path Guide* was not usually a breadth of logistics knowledge but a broad knowledge of the officer's functional career field. For example, in supply, it was recommended that the officer be assigned to the various branches within supply to get a breadth of knowledge. However, each career path did mention one assignment into one of the accession areas, such as the Reserve Officer Training Corps or Officer Training School, would provide the officer a breadth of experience.

What is disappointing is that leadership, management, and decisionmaking are mentioned very little in the *Career Path Guide* as requirements for the officer. Ironically, though depth and technical knowledge are at the top of the requirements list, training is either barely mentioned or not mentioned at all. This could be because the career managers expect officers will attend initial training schools. However, becoming as proficient as the Air Force indicates it wants and needs logisticians to be requires

	Leadership	Depth/ Tech Knowledge	Manage/ Decisionmaking	Training	Experience/ Ability	Breadth	Expert	Opportunity/ Goal
Log Plans	1	3	1	1	7	5	1	Installations and Logistics Dir—3 star
Supply	3	8	0	0	4	6	0	Dir of Supply—2 star
Mun & Missile MX	2	8	0	0	3	7	2	Wing CC—1 star
Transportation	2	6	0	0	4	5	0	Dir of Transportation—1 star
Acquisitions	3	9	0	0	4	5	0	Sys Prog Dir (Asst Sec AF for Acq)—3 star
Science & Research	3	10	0	0	4	6	0	None provided— No ideal path
Developmental Engineer	2	11	5	0	2	8	0	None provided—Recommend crossflow (AF CE)—2 star
Finance	4	7	0	0	3	6	0	Dep Asst Sec for Budget—2 star
Contracting	4	5	1	0	2	3	0	Dep Asst Sec for Contracting—1 star
Civil Engineer	0	7	0	0	2	3	0	CE of the AF—2 star
Communications	3	6	0	0	2	3	0	None provided—Senior Ldrshp (Dep Ch of Staff for AF Comm)—3 star
Personnel	8	7	1	0	3	3	0	MSS/CC—Colonel
Manpower	2	4	1	0	3	2	0	DCS for Personnel—3 star
Security	3	9	1	0	6	2	0	AF Security Dir—1 star
Office of Special Investigations	2	7	0	0	1	3	0	None provided—exceptional career
Public Affairs	3	7	0	0	5	4	0	Director of PA—1 star
Services	6	3	2	2	9	2	0	None provided—not only one career path

Figure 1. Logistics Officer Matrix

The only way to ensure America's security in the future is to train the warfighter and put the same focus on the logistician.

more than a few weeks of school at the beginning of a career. Additionally, preparing for agile combat is going to require specialized training for this new type of support.

As seen in the figure, almost anyone who does not operate a weapon system or maintain it is clumped into logistics and will be a group within a wing. With these vast areas of responsibility, having a depth of knowledge in all 17 areas is next to impossible, and it will not provide the Air Force the ACS officer needed for future engagements.

Additionally, career progression for most logistics officers is limited at best and is nonexistent in some of the logistical career fields. This comes from the desire to transform the strongest military in the world into a corporation. Whereas this is a topic for another day, making the military reflect corporate America is the answer to budget constraints, but it is not the right answer to keeping America militarily strong. The Air Force must have well-trained and experienced logistics officers at every level. It has often been said, "There is no substitute for experience." This is true for logistics officers as well. The only way to ensure America's security in the future is to train the warfighter and put that same focus on the logistician.

The logistics officer must be experienced and well trained; there must be a progression for the logistics officer that teaches through experience as well as the classroom. This progression will ensure the right person is at the right location to make the right decisions, and these decisions will be based on the best teacher in the world—experience. For example, through proper training and assignments, the senior logistics officer would be at the Joint or Air Staff level directing what, where, how, and when to send people, equipment, and supplies in support of the warfighter. The midlevel logistics officer would be on the front line or at forward operating locations, receiving supplies, people, and equipment; setting priorities; and ensuring proper distribution. The young logistics officer would be at the home base sending out items to the midlevel logistician, while gaining the knowledge and experience needed to move to the next level.

History has taught, time and again, that you can usually get the warfighter to a location, but without logistics, you cannot sustain the mission. If you cannot sustain the

mission, you will not win. Experienced, well-trained, and committed logistics officers will provide the plans and support necessary to meet wartime requirements because they have made the greatest investment—their lives' work.

Future Requirements

As previously mentioned, the smaller in-and-out conflicts of the recent past are what can be expected for future combat, and those situations will require Agile Combat Support. Agile Combat Support will provide logistical support across the entire spectrum of operations. These forces must be light, lean, and lethal. The support for them must be scaled down to provide a smaller footprint, responsive to support sustainment and sufficient to fulfill requirements.[8]

America's Armed Forces need to take a deeper look into what is needed for future short-term conflicts.

But what exactly is Agile Combat Support? There are a number of publications that refer to agile combat and discuss the support necessary for this type mission. However, I developed a simplified definition by breaking down each word: agile—quick and light in movement; combat—a battle or skirmish; support—to sustain without giving way.[9] Therefore, Agile Combat Support, for the purpose of this article, is defined as "The quick and light movement of personnel, supplies, and equipment necessary to sustain military operations."

The movement of personnel, supplies, and equipment is obviously the first stage. This will require extraordinary planning because no one knows exactly what will be needed for each mission or where that mission might take place. Proper logistics planning will reduce the need for taking emergency measures, which are usually expensive and can have an adverse effect on the overall mission.[10] Therefore, it is essential for the logistics officer to be not only familiar with the equipment needed to sustain each weapon system but also aware of the transportation requirements for movement. General Henry H. Shelton, Chairman of the Joint Chiefs of Staff, acknowledged this when he stated, "The route of sustainment is the lifeblood of combat power."[11]

Commanders cannot count on having the same opportunity General Norman Schwarzkopf did before he felt comfortable in initiating his operation during Desert Storm.

A look at common items would be a good place to start the planning process. For example, food and shelter are basic requirements for personnel, and fuel is usually a common necessity for equipment. Once a determination of common items is made, a good look at how these items are packaged would be beneficial. Is there a better way to package these items? Are there ways to lighten the load? These questions—and more—need to be asked, evaluated, and answered to ensure our present and future support is not packaged for the large masses from the Cold War mentality but for the *light and lean* conflicts of the future. It is the logistics officer who will be required to answer these questions.

So what is needed to support and plan for future agile combat—logistics officers who have received sufficient training and the experience necessary to allow them to properly plan and support these types of future conflicts. General John P. Jumper already has recognized this is necessary for the maintenance officer. And steps have been taken to ensure these officers are afforded every opportunity to learn and experience most, if not all, maintenance aspects so they can become knowledgeable leaders in their field.[12] This is a step in the right direction, but it must not stop there. Our senior leaders deserve to have the same confidence concerning logistics. They need the same type of expertise in the logistics arena as they have in operations and maintenance. Commanders cannot count on having the same opportunity General Norman Schwarzkopf did before he felt comfortable in initiating his operation during Desert Storm. With proper training and a true breadth of logistical knowledge and experience, it is possible to have the same confidence in logistics as there is in operations and maintenance.

Recommendations

As mentioned previously, logistics seems to be a catchall, but in reality, it is a very real arena. Therefore, the realignment of logistics should be considered. When a commander, either at a base or headquarters, needs information on logistics, there should be one expert who can provide that information. However, with the vast array

of career fields in logistics, having one expert is impossible. One consideration could be to take research and development, acquisitions, and developmental engineering out from under the logistics umbrella and make them their own area of expertise. This would greatly benefit the Air Force, as its future is dependent on these officers and the new technology they develop. Having military officers in these career fields with good career progression will ensure a healthy relationship between the operator and developer as well as ownership—the military member will not have conflicting loyalties.

Another recommendation would be to include munitions and missile maintenance in the maintenance career field, as senior leaders will expect to have one maintenance expert and not maintainers in the logistics field. Yes, this type of maintenance is different from aircraft maintenance just as contracting is different from supply in the logistics arena. However, it is important at this point to remember officers are not expected to be the technical experts but managers who ensure the mission is accomplished in the most efficient manner possible. It is the senior noncommissioned officers who are the experts, and the officers should rely on them for indepth and technical information. The officer is expected to manage resources, evaluate situations, and lead the way—not direct which wrench to use or which bolt to tighten.

It is important at this point to remember officers are not expected to be the technical experts but managers who ensure the mission is accomplished in the most efficient manner possible.

With these adjustments, a viable logistics officer is possible, with the exception of civil engineering. This area could stay under the logistics group at the base level, which would allow the Air Force to grow very effective engineers, as they understand the tactical requirements of effective base operations and mission support. Young engineering officers will acquire an understanding of the military mission at the base level. They will learn what needs to be developed and how it all comes together to support the greatest military on earth. Then, at the middle and senior level, military engineers will have the expertise needed to support agile combat whenever the occasion arises, whether from a research lab where they develop *light and lean* equipment or on the front line supporting the mission.

Agile Combat Support, for the purpose of this article, is defined as "The quick and light movement of personnel, supplies, and equipment necessary to sustain military operations."

If these changes are made, proper training of the logistics officer can begin. In technical school, the officer should first get a good working knowledge of the logistics group. The first block of study should be learning the various missions of logistics, then comes a deeper study of the logistics area they will be assigned to first. After 3 years, when the logistics officers are reassigned, they can return to school for specialty training required for their next assignment. There is already a precedence for this type of cross training or breadth of experience as operators do this every time they go into a new weapon system.

Conclusion

We must train as we fight. Agile Combat Support seems to be the way of the future. There may be other occasions where we will be afforded the opportunity to build up our masses before entering into a conflict; however, we cannot count on it. Plans for massive buildups already exist, but America's Armed Forces need to take a deeper look into what is needed for future short-term conflicts. In both instances, the trained logistics officer is invaluable. Logisticians will be the first to go in. They will investigate the security of the area, observe resources available for personnel and equipment, assess what additional supplies are needed, and ensure these items arrive in the quantities needed and when needed.

The pilot will no longer be alone in the empty field but will be flying high because of the combat support provided by the well-trained logistics officer. Who knows, this could be a great plot for a commercial or movie someday.

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Tanker Airlift Control

The Ultimate in Agile Com

Lieutenant Colonel Phil Bossert, USAF

TALCEs are the ultimate in Agile Combat Support

Elements
bat Support

Streamlined infrastructure, time-definite delivery, total asset visibility, and a reduced mobility footprint are the four overarching planks of agile combat support. They're all focused on being able to "get out of Dodge" rapidly with resupply and sustainment starting as the force is ready to engage.[1]

—Lieutenant General
William P. Hallin, USAF

In December 2001, the 821st Air Mobility Squadron (AMS), one of five squadrons of the 621st Air Mobility Operations Group (AMOG) at McGuire AFB, New Jersey, led two tanker airlift control elements (TALCE) into Bagram Air Base and Kandahar Airfield, Afghanistan. By the following April, all 225 airmen and officers—active duty, Guard, and Reserve from all five AMOG squadrons, team McGuire, and other bases—had returned safely, their missions completed. This article discusses what TACLEs are, how they are the ultimate in Agile Combat Support, recent deployments to Afghanistan, and lessons relearned from these deployments.

TACLEs

The term TALCE was created in 1994 when the AMOGs were established by General Ronald Fogleman, commander in chief, US Transportation Command (TRANSCOM) and commander of Air Mobility Command (AMC).[2] The creation of the AMOGs consolidated the TALCEs, formerly known as airlift control elements (ALCE), into two centralized locations. ALCEs had been in existence for years, and during the Vietnam War, numerous ALCEs were deployed throughout Southeast Asia. The basic organization and concept of operations of today's TALCEs began to take shape just

Tanker Airlift Control Elements: The Ultimate in Agile Combat Support

TALCEs provide three basic functions.

after Vietnam when the C-130s were sent to the Military Airlift Command in 1975.[3] These ALCEs were tasked to support airlift at locations where support was either very limited or nonexistent. The ALCEs would also train users from all four services on how to get the most out of the airlift system during peace and war.

The two TALCE *hubs* today include the 621st at McGuire AFB and the 615 AMOG at Travis AFB, California. The AMOGs are keys to expanding the fixed en route air mobility system and establishing air mobility operations where little or no support exists.[4] The mission of the TALCEs is to establish air mobility operations in all types of environments, from modern airports to the most austere combat zones. They provide three basic functions: command and control, aerial port, and aircraft maintenance. However, additional functions can be added as needed, including security forces, medical, finance and contracting, public affairs, translators, and many others.[5] Most TALCEs have a 12-hour response time, which means, once they get a deployment order, they must begin loading onto aircraft just 12 hours later.

A good way to picture a TALCE is this: about a hundred airmen, normally led by a senior captain or field grade officer, who deploy to set up a miniature and temporary McGuire, Dover, McCord, McConnell, or other air mobility base anywhere in the world. The AMOGs are a key part of the TRANSCOM's *first strike* capability. Once an airfield is secured, the TALCEs are normally the second team in, and only 4 hours after their arrival, they can begin receiving aircraft. An October 2001 article in the *New York Times* described the TALCEs as "the special forces of logistics," and the nickname of the 621st—*The Devil Raiders*—summarizes that description very accurately.[6]

Airlift planners sometime forget the amount of lift required for a TALCE. A good rule of thumb is this: for a maximum on the ground of four C-17s, 24 hours a day, 7 days a week in a bare base, medium threat environment, planners should use a 100-person TALCE to be deployed on five C-17s. This TALCE is completely self-contained and carries deployable rapid assembly shelters with environmental control units; meals, ready-to-eat; water for 5 days; generators; the famous Mobility Air Reporting

Communications System; ammunition and other firepower; various types of materiel-handling equipment (MHE); at least two pickup trucks; and several conexes and pallets full of additional equipment.

Importance of TALCEs to Agile Combat Support

The quote by General Hallin at the beginning of this article describes almost completely what the TALCEs do, except that they also allow forces to enter *Dodge*. But how are TALCEs the ultimate in Agile Combat Support? The answer is in their ability to rapidly deploy worldwide; set up operations just hours after arrival; and then work 24/7 to offload people, equipment, firepower, supplies, and anything else that can fit inside an aircraft.

The essential role of the ALCE and TALCE concept has been successfully proven scores of times in just the last 30 years. Some examples include Operation Nickle Grass in 1973 when the first scheduled airlift mission to Israel carried an ALCE; Desert Shield when the first American aircraft to land in Saudi Arabia carried an ALCE from McGuire; and in 1994 in Rwanda when one of the first units to arrive in Mombasa, Kenya, was a TALCE.[7] ALCEs and TALCEs were also used in Somalia, Haiti, the Balkans, and during many disaster assistance operations. The TALCE concept seems tailormade to support today's expeditionary aerospace force (EAF).

Air expeditionary forces are required to deploy and place bombs on target just 48 hours after receiving an execution order.[8] However, current logistics processes are unable to support this aggressive time line, and a recent RAND study suggested that global infrastructure preparation is "a central function of planning expeditionary support."[9] This study recommended prepositioning support as far forward as possible to help in meeting this time line and discussed the need to field numerous forward operating locations (FOL) to "provide a range of employment time lines for operational use."[10] Ironically, this study never mentioned anything about TALCEs that operate at FOLs and are key to rapid global mobility. The TALCEs are especially invaluable today because of the few fixed bases throughout the world that

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The 621st deployed three TALCEs and an air mobility division to four countries in the Persian Gulf.

the United States maintains. In 1989, the Air Force had 25 major bases and 400 smaller installations overseas; today, it has just 6 major bases and 78 smaller installations.[11] In addition, many contingencies in the last 10 years have been to countries where none of these bases and installations exists, requiring the unique capabilities of the TALCEs even more. Deployments during Operation Enduring Freedom were yet another example of the TALCEs' establishing FOLs in austere, medium-threat environments.

First Deployment: Back to the Gulf

Just 7 days after the 9/11 attacks, the 621st deployed three TALCEs and an air mobility division to four countries in the Persian Gulf. Most of the TALCE deployments to the Gulf lasted 7 weeks and were instrumental in allowing the bombing of terrorist targets in Afghanistan to begin less than a month after 9/11.

Second deployment: Into Afghanistan

The 821st AMS led TALCE deployments into Bagram Air Base and Kandahar Airfield in late December 2002. Although designed to be deployed for 30-60 days, these TALCEs were in place for almost 100 days until replaced by air expeditionary groups (AEG), which remain today. These TALCEs performed their missions effectively, safely, and professionally, while bringing home everyone they deployed with. Operations at Bagram and Kandahar were examples of seamless joint, multinational, interagency, and total force operations. Everyone worked well at the tactical level, and a key reason was that the TALCEs constantly talked to their users, established liaisons with their major users, and were very customer-oriented and professional. A lot has been written over the years about joint and multinational operations, and this all comes down to making the effort to talk to one's counterparts, no matter what service or country they might belong to.

Lessons Relearned

The TALCEs in Afghanistan operated in the highest threat environment any TALCE had deployed to since the Vietnam War. Although their performance was remarkable for what they allowed to be airlifted in, these deployments

were not perfect, and several lessons were learned. General Walter Kross, former commander of TRANSCOM and AMC, used to refer to lessons learned as lessons relearned, and that term is easily applied to the TALCE experiences in Afghanistan. Key lessons relearned include the importance of training as you will employ, maintaining high mobility readiness, the need to reorganize the TALCE Reserve components, the need to more effectively market TALCE capabilities, and the urgent requirement for AMC to better support the TALCEs.[12]

Training

Every 2 years, Army infantry brigades are certified combat ready by successfully completing JRTC, and TALCEs almost always participate.

Training as one will employ is essential. There were three reasons for the success of the 621st in Afghanistan: its annual participation in the Joint Readiness Training Center (JRTC) exercise held at Fort Polk, Louisiana; annual Air Base Ground Defense (ABGD) field exercises conducted at Fort Dix; and in-garrison training required for rapid deployment into an austere, medium-threat environment. This training philosophy allowed the TALCEs to be very mobile, another lesson relearned from these deployments.

Every 2 years, Army infantry brigades are certified combat ready by successfully completing JRTC, and TALCEs almost always participate. Coincidently, at Bagram, the TALCE worked with the 10th Mountain Division, the same division it had worked a JRTC with the previous April, and at Kandahar a member of the Canadian TALCE recognized the 821st TALCE and said, "I remember you guys from JRTC!" He also remembered how at JRTC the 821st had bought his team a case of Samuel Adams for the superb work it had done. At Kandahar, that teamwork continued, seamlessly and professionally.

ABGD involves 2 days in the classroom where every page of the *Airman's Manual* is reviewed, and then the participants are deployed as a TALCE into a simulated combat environment for 4 days and 3 nights. This is expertly conducted by the 621st Force Protection Flight, using numerous scenarios. As it turned out, this training was much more demanding than what was experienced at Bagram and Kandahar and directly contributed to the TALCEs' experiencing no fatalities. In addition, the 621st

The first AMEX involved casualty notification and assistance and was conducted 18 months before the TALCEs deployed to Afghanistan.

had created its own night-vision goggle MHE training course essential for operations in Afghanistan but one that AMC did not know the TALCEs had. This allowed the TALCEs at both Bagram and Kandahar to conduct continuous night operations, which were essential to their missions, especially during the first month in country.

Another essential aspect of AMOG training was the monthly sessions that took 1 hour and consisted of guest speakers who were subject-matter experts. Termed air mobility in-house exercises (AMEX), they were created from the 821st AMS innovative idea program. The first AMEX involved casualty notification and assistance and was conducted 18 months before the TALCEs deployed to Afghanistan. The casualty notification officer from McGuire and the squadron chaplain both participated and led discussions, including the composition of the notifying party, the duties of a family liaison officer, and how to plan and conduct a memorial service. No other squadrons at McGuire had done this training to be ready for the unthinkable. Fortunately, the 821st never had to use that training. Other AMEXs included finance and contracting, public health, media training (which came in handy more than ever imagined), explosive ordnance disposal, force protection, family support, legal, and many others.

Mobility

Another key lesson relearned was the importance of mobility. Mobility is clearly a key to readiness and helps make the TALCEs an impressive example of Agile Combat Support. The AMOGs are required to have a 12-hour response time and often are depended upon to deploy that quickly. On every deployment, whether planned or short notice, there are inevitable little snags, but two techniques minimized these snags greatly: requiring all personnel returning from a deployment to complete a reconstitution checklist to ensure they were prepared to deploy again immediately and maintaining all AMOG equipment in a large deployment facility and dividing that equipment into alert packages for rapid deployment. One of General John P. Jumper's concerns is getting the entire Air Force into an EAF mindset. A good way to do this is to put a lot more people on mobility status and then conduct mobility exercises.

Reserve and Guard TALCEs

A third lesson relearned was the need to reorganize the Air Reserve Component (ARC) TALCEs**.** As the TALCEs transitioned to AEGs at both Bagram and Kandahar, many of the AEG members were from the Guard and Reserve. Overall, they did an excellent job and were often indistinguishable from their active-duty counterparts. However, the back-to-back deployments the active duty TALCEs experienced to the Persian Gulf and then Afghanistan were demanding, and clearly, the ARC TALCEs could have provided some relief.

Two-thirds of the Air Force TALCE capability is in the ARC, but only a small percentage was mobilized for Operation Enduring Freedom. However, these TALCE equivalents are simply the command and control portion; aerial port and maintenance come from other ARC units. From September 2001 until April 2002, the 621st TALCEs deployed nearly continuously, and many wondered why the ARC TALCEs were not utilized more. One reason is because the ARC TACLEs are not organized to deploy as quickly as traditional TALCEs. With more than 72 percent of the aerial porters, 54 percent of all maintainers, and 67 percent of the command and control, the ARC could be much more effective in the TALCE world only if they were reorganized as traditional TALCEs.[13] Perhaps their lack of participation in Enduring Freedom, despite their tremendous capabilities and well-trained and well-led personnel, will finally force AMC to consider this proposed reorganization.

The ARC TACLEs should be reorganized as complete TALCEs, similar to their active-duty counterparts with command and control, aerial port, and maintenance, all in one unit.

To be more effective, the ARC TACLEs should be reorganized as complete TALCEs, similar to their active-duty counterparts with command and control, aerial port, and maintenance, all in one unit. If this is done, the ARC TALCEs may be used for more than simply augmenting command posts, as stage managers, and as individual replacements for active duty TALCEs.

Marketing

A fourth lesson relearned from Operation Enduring Freedom was the need to better market TALCE capabilities. Many people still do not know what the TALCE community does, including some officers in AMC and our many users. The TALCEs in Afghanistan briefed more than

To correct this marketing problem, AMC must relook the affiliation program, which heavily involves the AMOGs.

one Army 0-6 in the 10th Mountain Division and 101st Airborne Division—some of the most mobile divisions in the Army—on what TALCEs are because they did not know before they worked with the TALCEs. With the enormous emphasis the Army Chief of Staff, General Eric Shinseki, has placed on making the Army more agile and mobile, this was hard to believe.

Clearly, when your customers do not know your mission, much less your own command, how can you get support to do your job effectively? You cannot, as shown by the lackluster support of the AMOGs since they were created by General Ronald R. Fogleman in 1994. We have continued to be starved of adequate personnel, especially rated personnel, and funding along with modern equipment—especially the latest communications equipment—but above all, respect. To correct this *marketing* problem, AMC must relook the affiliation program, which heavily involves the AMOGs. The affiliation program teaches thousands of students a year from all four services on how users can get the most out of the air mobility system. Also, it should be a requirement that all newly selected flag officers from all the services visit an AMOG and see what we do. It would be to their advantage, because the success of a deployment they might lead someday could depend on their knowledge of the TALCEs.

Another effective way to market TALCE capability is through public affairs. The TALCE at Bagram was the only TALCE that had requested a public affairs officer during any recent deployment, and he was essential in interfacing with the media. He got the TALCE lots of great press that it would not have gotten without him, including stories in the *L. A. Times, Fox News, CNN,* and *Air Force Times*. This helped get the word out about what TALCEs are and their essential role in Agile Combat Support.

Better Support Needed From AMC

The final lesson relearned is perhaps the most important one—AMC must support the TALCEs better**.** Eighteen months before they deployed into Afghanistan, a senior officer at AMC made a comment at a transportation conference to the effect "he didn't know exactly what the AMOGs do, but we need those aerial porters and

maintainers back on the flight lines." This comment is a perfect example of someone's being military history challenged, because hundreds of years of Western military experience clearly show that units that train effectively in peacetime will perform much better in wartime than those units that are thrown together at the last minute. In his book *Citizen Soldiers*, Stephen Ambrose describes how individual replacements were sent to US units in Western Europe during World War II and how they often did not survive the first few days at the front.[14] The same goes for TALCEs—you cannot patch together command and control from one base, aerial port from another, and maintenance from a third and hope to have an effective TALCE hours later, especially in a combat zone.

The efficiency and effectiveness of the entire air mobility system would improve if more action officers and their division chiefs were on mobility status and deployed into the system to see first hand the product of their labors and the conditions of their counterparts on the front lines. If Headquarters AMC personnel spent a day sleeping in one of the TALCE's oven-like temper tents at Kandahar, environmental control units would have arrived much faster. The technicians at AMC would be amazed to see the end result of hundreds of millions of dollars in information technology funding since the Gulf War, especially when AMC would call the TALCE at Kandahar on a DSN line to get departure times. The TALCE response was usually, "Why don't you get this from the air mobility division?" And their response was normally, "Their phones are always busy!"

The efficiency and effectiveness of the entire air mobility system would improve if more action officers and their division chiefs were on mobility status and deployed into the system to see first hand the product of their labors and the conditions of their counterparts on the front lines.

Conclusion

General Fogleman has said that the half-life of information is tied directly to the average duration of a single assignment, and for most military people, that turns out to be 3 years.[15] The importance of training, mobility, the need to reorganize the ARC TALCEs, better marketing of TALCE capability, and garnering stronger support from AMC were all lessons relearned from Enduring Freedom. While every deployment offers many relearned lessons, the TALCEs at Bagram and Kandahar continued the uninterrupted AMC tradition of accomplishing the mission

Those logistic professionals, they are like the linemen of a football team.

despite enormous challenges and proved once again that they are the ultimate in Agile Combat Support. Their quiet but enormous contribution to Agile Combat Support was aptly summarized by General Gregory Martin, commander of the European Command, when he said, "Those logistic professionals, they are like the linemen of a football team. They get no recognition; they get no appreciation. But we cannot move without them."[16]

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Logistics Stuff—Five Things to Consider

Group Captain David J. Foster, RAF, "Fightn' N' Stuff,"*Logistics on the Move*

- **The operations/logistics partnership is a target for our enemy—protect it.** We must try always to think of an enemy's looking for the decisive points in the partnership. What we want to make strong, they will try to weaken. Where we want agility, they will want to paralyse us. What we can do to our enemy, we can do to ourselves by lack of attention. So all concerned with operations and logistics must protect and care for the partnership and the things it needs for success. This includes stuff and information and people. Also, we must not forget the corollary is just as important: the operations/logistics partnership of the enemy is a target for us; we must attack it.
- **Think about the physics.** Stuff is heavy, and it fills space. Anything we want to do needs to take account of the weight that will have to be moved, over what distance, with what effort. Usually this all comes down to time, a delay between the idea and the act. If we think about the physics we can know the earliest time, we can finish any task and we can separate the possible from the impossible. It is crucial to determine the scope of the physical logistics task early in any planning process. Planners must know how long things take and why they take that long.
- **Think about what needs to be done and when—and tell everybody.** Once we have given instructions and the stuff is in the pipeline, it will fill that space until it emerges at the other end. The goal is to make sure that the stuff coming out of the pipe is exactly what is needed at that point in the operation. If it is not, then we have lost an opportunity—useless stuff is doubly useless, useless in itself and wasting space and effort and time. Moving useless stuff delays operations. Also, priority of order of arrival will change with conditions and with the nature of the force deploying. For example, the political need to show a presence quickly may lead a commander to take the risk of using the first air transport sorties to get aircraft turn-round crews and weapons into theatre before deploying all the force protection elements.
- **Think about defining useful packages of stuff.** Stuff is only useful when all the pieces to complete the jigsaw are assembled. Until the last piece arrives, there is nothing but something complicated with a hole in it. It is vital to know exactly what is needed to make a useful contribution to the operational goals and to manage effort to complete unfinished jigsaws, not simply to start more. Useful stuff often has a *sell-by* date. If it arrives too late, it has no value, and the effort expended has been wasted. The sell-by date must be clear to everyone who is helping build the jigsaw. And it is important to work on the right jigsaw first. In any operation, there is a need to relate stuff in the pipelines to joint operational goals, not to single-service or single-unit priorities. It is no good having all the tanks serviceable if the force cannot get enough aircraft armed and ready to provide air cover or ensuring that the bomber wing gets priority at the expense of its supporting aircraft.
- **Think about what has already been started.** The length of a pipeline is measured in time not distance. There will always be a lag in the system, and it is important to remember what has already been set up to happen later. Constantly changing instructions can waste a lot of energy just moving stuff around to no real purpose. Poorly conceived interventions driven by narrow understanding of local and transitory pain can generate instability and failure in the system.

The Air Reserve Component had the personnel with the Air Force specialty codes and experience needed, but executing the fills was highly improbable.

Robusters

Fog Insurance for Agile Combat Support

Lieutenant Colonel Dale R. Wise, USAF

Introduction

By mid-January 2002, three months into Operation Noble Eagle and Operation Enduring Freedom (ONE/OEF), the Air Combat Command (HQ ACC) Crisis Action Team received calls for manpower requests from 13 stateside ACC bases. The bases requested 225 aircraft maintenance reservists to fill positions vacated by those who had deployed. The requests were made to enable ACC bases to fill the unexpected losses of experienced personnel and still maintain a stable flying-hour program. By May 2002, less than 20 qualified reservists were located and had volunteered for ACC tours ranging from 90-365 days. The reality of the situation shows that the Air Reserve Component (ARC) had the personnel with the Air Force specialty codes (AFSC) and experience needed, but due to organizational structures, executing the fills was highly improbable. The Air Force Reserve Command (AFRC) and Air National Guard (ANG), which make up the Air Reserve Component, were both reluctant to release aircraft maintenance personnel because they might be mobilized for ONE/OEF. Most of the volunteers came from the AFRC Individual Mobilization Augmentee (IMA) program and were assigned to other major commands (MAJCOM). Their

availability to ACC was only possible because the MAJCOMs approved their release with the understanding that if they were needed they would return immediately to their official IMA assignment for duty.[1]

Thesis

The Air Force does not have enough qualified aircraft maintenance IMAs positioned to support ACC shortfalls when unexpected exigencies like ONE/OEF take place.

The proposed solution will be a new concept based on the current push to transform the Air Force into a more responsive agile force.

Overview

The purpose of this article is to establish a solution to resolve the shortage of qualified aircraft maintenance IMAs when unexpected events surge flying operations. The proposed solution will be a new concept based on the current push to transform the Air Force into a more responsive agile force. The solution is directly linked to the air and space expeditionary force (AEF) and its core competency of Agile Combat Support (ACS). The AEF embodies the Air Force vision to organize, train, equip, and sustain its future total force—active, ANG, and AFRC—to meet the challenges of the 21st century.[2] To get to the solution, four areas that provide the background to the problem and the trend for innovative solutions will be discussed. Part one covers the investment made in Air Force aircraft maintenance personnel and why they separate from the service. Second, a successful IMA program is examined; third, a General Accounting Office (GAO) report is referenced as a possible reason for the ACC bases' unplanned shortfalls of Reserve maintenance personnel. Next, addressed is the push for transforming the Air Force into a more responsive, flexible force. Finally, a proposal is introduced to tie the four areas into a flexible program that would benefit ACS and the future total force.

Maintenance Personnel

From 1997 through 2000, retention of experienced Air Force maintenance personnel declined significantly. The rate of decline varied among both AFSC and reenlistment categories (first-term, second-term, and career), but in virtually all instances, retention rates were lower than established goals. The impact of reduced retention on the

Air Force mission manifests itself in different ways. With regard to some AFSCs, the impact is believed to be extremely negative.

According to the ACC Director of Logistics, the continued shortfall in maintenance personnel could jeopardize execution of the annual flying-hour program and cause ACC to fall short of meeting the combatant commanders' wartime requirements.[3] Poor retention rates and increased competition for limited funding over the last few years have forced most Air Staff career-field managers to increase the level of justification needed for securing increases in selective reenlistment bonus (SRB) funding for the retention of experienced personnel. In the aircraft maintenance community, numerous career fields have lost (and continue to lose) experienced personnel, which has negatively impacted aircraft availability and readiness levels of most types of aircraft. Unfortunately, current SRB funding falls short of the amount needed to retain larger numbers of experienced maintenance personnel.[4]

Research from the Air Force Logistics Management Agency (AFLMA) reveals the amount of money the Air Force invests in a typical 5-level maintenance technician falls between $116K and $170K, with the average being $135K. Specialized training in some of these career fields, such as low observable aircraft structural maintenance, can drive the investment even higher. Analysis from the AFLMA special study shows the Air Force has severely underestimated the substantial training investment it makes in maintenance personnel. The study also revealed the value of these personnel to the Air Force by showing, from a historical perspective, what the relationship has been between experienced 5- and 7-levels and readiness in terms of aircraft availability. If these historical relationships hold true in the future, career-field managers can quantitatively demonstrate that retention of experienced personnel not only is more cost-effective but also leads to a more productive and experienced workforce. This, in turn, would improve aircraft maintenance and availability, which drives Air Force readiness.[5]

In addition to the AFLMA findings, a RAND study directed by Project Air Force focused on the setting of requirements for Air Force maintenance personnel. The

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Research indicates Air Force manpower processes do not adequately account for all valid tasks performed by maintainers in the field.

study reviewed the size and composition of active-duty enlisted manpower in wing-level aircraft maintenance organizations and included research on maintenance apprentices, journeymen, and craftsmen in operational units, such as fighter, aircraft generation, and maintenance squadrons. The overarching conclusion of the RAND study showed maintenance manpower requirements are, indeed, underestimated. In general, the research indicates Air Force manpower processes do not adequately account for all valid tasks performed by maintainers in the field.[6]

In linking these two studies, one can conclude that 5- and 7- level Air Force maintenance personnel are overtasked and underpaid. This has led the experienced maintainers to leave the force in unexpected and unwelcome numbers. The results of these analyses do not suggest that adding manpower is necessarily the appropriate solution to these situations. Remedies should reach beyond manpower to new concepts, both for organizing wings and squadrons for conducting maintenance production.[7]

IMA Program

If adding more active-duty maintenance manpower is not the recommended solution and developing new improved concepts is the direction to proceed, maybe the Air Force should bolster the IMA program as a possible relief to counter the exodus of maintenance personnel. Like unit reservists, IMAs are the first-line backup for the Air Force in the event of war, national emergency, or natural disaster. IMAs make up one of the most flexible and cost-effective elements within the Department of Defense (DoD). Today, approximately 12,000 Air Force IMAs are assigned to active-duty units to support contingency operations or pre- and post-mobilization requirements. However, IMAs are unique in that they operate somewhat unilaterally, conducting their service lives outside the traditional organizational structure of the unit program, in conjunction with the needs of their assigned active-duty unit. The IMA peacetime mission is readiness, and as such, IMAs are an integral part of the total force. Survey results documenting Reserve programs in Desert Shield and Desert Storm showed that 97 percent of all commanders

said IMAs contributed to their command's wartime mission.[8]

One exemplary example of the expanded use of logistics IMAs is the Air Force Reserve Ammunition Team (AFRAT). The IMA billets were created under traditional wartime directives, but the program is of great benefit to the Air Force in peacetime. The AFRATs are Air Force munitions technician IMAs attached to Army depots that store Air Force ammunition. Their function is to provide surge capability in time of war, but they also maintain Air Force munitions during peacetime. The AFRAT program was established in 1995 and is assigned to Hill AFB, Utah.[9]

On 11 September 2001, the Air Force Ammunition Control Point at Hill surged into 24-hour, 7-day-a-week operations preparing for the impending, inevitable military response. When the Air Force Materiel Command (AFMC) began deploying its active duty personnel to support OEF taskings, they discovered a critical shortfall of skilled munitions technicians. To fill this void, the Air Force rapidly mobilized the AFRAT IMAs. The Ammunition Control Point directed AFRAT in the repair, inspection, shipment, and inventory management of conventional munitions items. According to the Air-to-Surface Directorate, they filled this void in an extraordinary manner. The AFRAT IMAs are supporting the local Ammunition Control Point, and the Air Force has also placed them on extended active duty to provide onsite support to OEF munitions operations at priority munitions storage locations across the country.[10]

AFRAT IMAs bring to their active duty units the skills and expertise that are in critical demand, such as munitions inspectors and production supervisors.

AFRAT IMAs bring to their active duty units the skills and expertise that are in critical demand, such as munitions inspectors and production supervisors. Within a short time, the Hill AFRAT IMAs were entrusted with complete munitions operations. Referring to the support IMAs have provided since 11 September, the Ammunition Control Point chief stated:

> AFRAT epitomizes the total force policy and has become a critical part of our mission capability. They have become a fully integrated part of active-duty operations. They have the expertise to step in when needed and get the job done. In the process, the AFRAT IMAs have earned the appreciation and respect of their active-duty counterparts.[11]

Air Force total force manpower requirements are determined by individual MAJCOMs.

The early success of AFRATs, prior to ONE/OEF, prompted AFLMA to study the potential for expanding the use of IMAs in others logistics career fields. AFLMA was tasked to study the current use of logistics IMAs, look at the AFRAT program, and determine if it is feasible to use more enlisted logistics IMAs to support Air Force mission requirements. The study, which included a survey of logistics experts and extracted data from the Air Reserve Personnel Center (ARPC), concluded with two major findings. First, the experts determined there is clearly room to expand the use of IMAs in logistics career fields. Second, the analysis of ARPC's database distinctly showed that logistics IMAs can be found to fill new allocations. The results of the AFLMA study noted that, below the MAJCOM level, there is poor awareness of what IMAs are, how slots are created, and how the program works. The study found, with continued downsizing, it is crucial that logisticians at all levels take a close look at the IMA program and attempt to use this resource to augment their capabilities. The study concluded that IMAs are a force-enhancing opportunity the Air Force should not ignore.[12]

Total Force Structure

Air Force total force manpower requirements are determined by individual MAJCOMs, using a number of methodologies, including manpower standards and logistical models. Once approved by Air Force leadership, the results serve as the basis for authorizing military, civilian, and contractor positions. The Air Force enters these positions into a program called the Manpower Data System, the Air Force's official source of manpower authorization data for Air Force, ANG, AFRC, civilian, and contractor personnel.[13]

To assess whether the authorized manpower was adequate for the wartime scenario, the Air Force compared the authorized forces in the Manpower Data System to deployment commitments demanded by the two major theater war scenario. It then calculated the effect of deploying these forces on the manpower needed to continue operations at existing airbases. The requirements for in-place support forces were calculated using a model that adjusts manpower requirements to account for changes

in personnel needed to support ongoing Air Force operations when forces are deployed. The Air Force never finalized plans for assessing the adequacy of total force requirements.[14]

The General Accounting Office (GAO) recently reported to Congress that the Air Force had not made a periodic total force analysis a high priority. The report relayed that without a regular, institutionalized process, the Air Force denies the Directorate of Manpower and Organization a way to determine objectively whether it has the forces needed to carry out the defense strategy. The GAO Total Force Assessment concluded the Air Force cannot demonstrate objectively that it has the forces necessary to carry out the full spectrum of military operations called for in defense guidance; therefore, its operational risk, in both wartime and peacetime, may not be fully understood. Air Force officials acknowledged that the total force assessment is used by functional managers to explore increasing the use of Reserve forces to mitigate shortfalls in the active forces.[15]

If Air Force functional managers base their decisions on inaccurate information, then it is understandable why active shortfalls happen and Reserve forces are not in position when the need arises.

The importance of the GAO report, in relation to the solution, is that past Air Force total force assessments were incomplete and not a high priority. If Air Force functional managers base their decisions on inaccurate information, then it is understandable why active shortfalls happen and Reserve forces are not in position when the need arises.

Transforming the ARC

Today, the Air Force integrates the Air Reserve Component into the planning and execution of all operations, making it an essential element to the total force. As the total force transforms to meet challenges of the future, it is essential that the Air Reserve Component be part of that transformation. The *2001 Quadrennial Review* emphasized that transformation should "enhance military capabilities and overhaul management systems in order to more effectively and efficiently fulfill the mission of the Department of Defense."[16] The new defense strategy calls for a fresh examination of how active and Reserve capabilities are organized. These changes will require a more flexible force than exists today—a force that is capable of dealing with many unknowns. There are two

The Air Force should explore creative ideas to better use flexible Reserve programs.

overarching themes of how the Reserve components can transform to meet the challenges set forth in the new defense strategy. They are rebalancing to enhance capabilities and creating flexibility in force management. Enhancing force capability through rebalancing seeks changes the Services can make to increase force agility, enable better management of operational tempo, and foster closer integration between active and Reserve components. Creating flexibility in force management seeks better ways to access and manage the total force.[17] The *Quadrennial Review* also identifies streamlining management practices to simplify duty statuses and facilitate the combatant commander's ability to use ARC personnel when needed. Incorporating more flexibility in Reserve personnel policies can eliminate complexity, which will yield greater efficiency.[18] Using the DoD vision on total force transformation as a guide, the Air Force should explore creative ideas to better use flexible Reserve programs.

Robusters

More than 170 years ago, Karl von Clausewitz, the legendary developer of Prussian military strategy, coined the phrase *fog of war*. A simple definition of the *fog of war* is uncertainty about the enemy, environment, and friendly forces.[19] The goal of this article is to foster a vision of how to fix the unexpected shortfall of experienced Reserve maintenance technicians that impacted ACC during the early phase of ONE/OEF. Developing the vision to fix manpower problems in an uncertain environment will benefit the future development of Agile Combat Support. By preparing an accurate force structure based on current and projected requirements, the Air Force can be proactive in preventing the next shortfall of Reserve aircraft maintenance personnel. The proposal to help resolve this aircraft maintenance technician shortfall deals with building a special IMA program tailored for experienced aircraft maintenance technicians who are leaving active duty. While the AFLMA study on Air Force maintenance personnel focused on costs and valuation of experienced 5- and 7- level personnel, it did not consider the IMA program as a way to retain this talent in the Reserves. With the typical 5-level maintenance technician leaving active

duty with $135K invested in training and retention expenses, it makes sense to aggressively retain that investment in the Air Reserve Component. Unfortunately, if the ARC unit programs are full in the geographical area where the individual wants to live, it will hamper the individual's ability to serve in active Reserve status. AFMC has the Air Force's largest IMA program, but finding the right position, in the right grade, at the right location may be difficult for those leaving the active force. While flexibility is a great attribute of the IMA program, it is built around projected manpower requirements authorized year to year. Some of these authorizations remain unfunded and may not be available to maintenance technicians leaving the Air Force. The GAO report to Congress stating the Air Force had not made a recent total force assessment a priority further convolutes the process by not providing current manpower guidance at the time the authorizations are made. This process makes it somewhat difficult for an individual to transition into an IMA position at the time and place needed. The Air Force should consider developing a special Reserve IMA program to retain experienced aircraft maintenance technicians leaving active duty. Reserve recruiters could then target quality individuals into this special maintenance organization when they separate from the Air Force.

The Air Force should consider developing a special Reserve IMA program to retain experienced aircraft maintenance technicians leaving active duty.

The success of the AFRAT program is a model that can be used to build a special team of IMA maintenance technicians. This team of IMAs could consist of 600 experienced aircraft maintainers who could be assigned to the three AFMC depots for training. The mission of this IMA maintenance team would be to *robust* the active duty flying units any time a shortfall occurs because of unexpected exigencies, hence the name *robusters.* The *robusters* would consist of crew chiefs and aircraft structural, aircraft electrical, aircraft fuel, aerospace propulsion, aircrew egress, avionics and maintenance production personnel with diverse aircraft experience across the organization. The *robusters* could be to active duty aircraft maintenance what the combat logistics support squadrons are to depot maintenance, only with a different mission. Their mission would be to fill stateside, overseas, and AEF manpower shortfalls until active duty aircraft maintenance personnel get in place.

Having a program like the robusters *in place could provide a stabilizing option for 30-90 days or until the Air Force could make plans to correct the situation with the next scheduled AEF rotation.*

While the *robusters* are IMAs, they would be part of a special maintenance team that would require a higher state of readiness than typical reservists, and the Air Force could offer special benefits for their involvement. The *robuster* program would be a good investment for two reasons. First, with a team of 600 experienced IMA aircraft maintenance technicians, the Air Force could continue to capitalize on its $80M+ investment (600 x $135K) for a fraction of the cost of active forces. Second, the program provides *fog insurance* for the Air Force mission in an uncertain world. For example, if there were a catastrophic accident involving Air Force maintainers en route to an AEF rotation, the likely solution will be to bump the rotation schedule to find individuals to fill the gap. This, in turn, stresses the AEF system and disrupts the active duty stability of those who get a short notice task to depart to the designated overseas location. *Robusters*, on the other hand, would be trained and equipped to depart wherever tasked in 48-72 hours. Having a program like the *robusters* in place could provide a stabilizing option for 30-90 days or until the Air Force could make plans to correct the situation with the next scheduled AEF rotation.

Conclusion

The purpose of this article has been to establish a solution to resolve the shortage of qualified aircraft maintenance technicians the Air Force has in reserve when unexpected events surge the active force. If the concept is feasible, a test program could be launched to work out the details. If the program is a success like AFRATs, the concept could be expanded to include other logistics AFSCs if needed. It could also be expanded to include support for other MAJCOMs— the Air Mobility Command, Air Education and Training Command, Air Force Special Operations Command, Air Force Space Command, Pacific Air Forces, and United States Air Forces in Europe. If a topnotch program is developed and the right people are recruited, *robusters* could provide 21st century *fog insurance* for Air Force Agile Combat Support.

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Understanding coalition capabilities and their needs becomes a must prior to waging war.

Coalition Support

Could It Be Shaped to Provide Agile Combat Support to Multinational Operations?

Lieutenant Colonel Hassan Fakri, RMAF

Coalition support bridging the coalition members' capabilities to seek the synergy to meet the Agile Combat Support characteristics.

All the major wars of this century have been multinational efforts, fought and won by coalition forces, bringing diversity of all mankind, inventions, materials, doctrines, and tactics into the theater of operations. Coalition warfare is not a new phenomenon challenging military commanders and neither are the difficult problems posed by logistics. Experience has shown there is a lot to do to optimize the logistics of these operations under the Agile Combat Support (ACS) guidelines.

To achieve this purpose, understanding coalition capabilities and their needs becomes a must prior to waging war. In this context, coalition support has to be prepared well in advance to save time, reduce expenses, minimize vulnerability, and ensure effectiveness and efficiency. Logistics concepts, such as Focused Logistics and Lean Logistics, could be adapted to enhance the coalition's logistics ability to support and sustain the multinational operations. We could rephrase General Henry Viccellio's statement "Lean logistics bridging the past and the future" by saying, "Coalition support bridging the coalition members' capabilities to seek the synergy to meet the Agile Combat Support characteristics: light, lean, and tailored."[1]

The coalition support will serve the purpose of the logisticians' future vision, which is moving away from the idea of deploying

Coalition Support: Could It Be Shaped to Provide Agile Combat Support to Multinational Operations

The coalition's support must also evolve to meet the needs of future multinational operations, and the diversities must be shaped to reduce barriers and ease integration.

materiel and personnel en masse, and focusing on deploying on-time delivery to the use of existing coalition partners' logistics inside or near the theater of operations.[2]

A better understanding of friends and allies' logistical capabilities, transportation means and systems, infrastructure, language, and training experience will lead to a smooth logistics integration of different actors in the coalition effort.

The coalition partners will shape and leverage their capabilities, through knowledge and understanding, to build trust among the members. Then, planning, training, and wargaming with the use of adequate and affordable new information technology tools will enable the coalition's logistics to reach the prerequisites of Agile Combat Support. Diversity of the partners' infrastructure, weather, and geographic locations is key to promoting and enhancing coalition support whenever a military multinational effort is needed on the globe. The lessons learned from recent military conflicts, with regard to the partners' contribution of logistics support, tends to stress the need of planned and organized coalition support to stretch Agile Combat Support beyond US logistics frontiers.[3] Organization of the coalition's support will enhance economy, safety, and security and will maintain efficiency and effectiveness in responding to needs of the fielded forces.

The experience of the US Armed Forces from previous conflicts in the logistics arena shows logistics is in constant evolution to respond to the warfare challenges. The coalition's support must also evolve to meet the needs of future multinational operations, and the diversities must be shaped to reduce barriers and ease integration.[4] Documented examples of the coalition's support show good results and promise for more in the future to meet ACS performances.

Coalition Diversities

Each member of the coalition is different and will bring diversities into the warfighting equation. These diversities include warfighting materiel, culture and language, experience, and technology.[5] These diversities, including geography and climatic differences, will challenge the

coalition's commanders. The commanders must understand the diversity of their partners and shape logistical capabilities to fit the criteria of Agile Combat Support. The process to integrate these diverse parameters must focus on how to shape these capabilities to optimize their use and support the coalition in different operations, from warfighting to peacekeeping.

Geography and weather require special emphasis, a good understanding, and better integration to enhance the coalition's capabilities to support operations.

Materiel

Like materiel is critical to coalition operations. Manufacturers of weapon systems and airlift assets will vary from one coalition member to another. These variations and differences are identified followup references, configurations, and maintenance procedures. To better understand, integrate, and optimize the use of these capabilities with safe and secure procedures, these variations should be identified and researched to reduce these dilemmas.

Experience

Diversity of experience will increase mutual understanding and ease the integration of personnel in the application of logistical concepts. Diversity of experience will ignite the emergence of new ideas and concepts in the logistics arena.

Language

Language must be dealt with prior to any coalition efforts. The goal is to use a universal language to prevent misunderstanding. The introduction of new information technology will ease the language barriers among the coalition's partners. The use of standard information technology language will be easy to develop and evaluate to reduce misunderstanding, misperception, and misinterpretation. Universal language and webbing will be secure and save time for the coalition's logistics business.

Technology

Each coalition member brings different technologies to the warfighting table. These technologies have different roots and stand at different levels. Used together, these

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technologies will cause problems associated with software compatibility and congruence.[6] Their integration also will need the development of hardware and software interfaces to permit the connection of the hardware and the translation of the software languages.[7]

Geography and Climate

Geography and climate are natural variables that could influence the coalition's support in many ways. Weather also has a direct influence on transportation infrastructures and communication means. It can initiate corrosion phenomena on hardware and materiel and affect logistics support. Knowledge of partners' geography and a good understanding of their weather will ease the burden on coalition support and increase the effectiveness of partner participation. These elements are very important and should be taken into account during the planning and preparation phases. Efficient use of geography and weather will optimize the flow of the coalition logistics.

Efficient use of geography and weather will optimize the flow of the coalition logistics.

Coalition Support Integration

The coalition needs to integrate and optimize use of all these diversities in the logistics arena to gain leverage. Integration will permit the synergy necessary for efficient and effective Agile Combat Support, key to success, of the expeditionary forces.[8] This is easy to say, but in reality, it is very difficult to achieve, for many reasons. Difficulties could be political, economical, or military, depending on each member of the coalition, and will require a lot of work in making procedures and adapting laws and policies. *Visionary leadership* is needed to show coalition members the path and lead partners through complex environments. The coalition should learn from previous experiences and use existing concepts and processes. This approach will seek coalition support and allow cohesion and a way to enhance interoperability among the partners' forces. Sensitive areas will not be addressed, and access of shared information must be safe and secured to avoid animosities. To support the coalition forces, logisticians have to deal with the essential functions of support, manning, arming, fueling, fixing and maintaining, moving, and sustaining the forces on the field.[9] These functions require a better understanding of each partner's logistical environment. To

gain increased understanding, coalitions will have to share logistical data, which should include accurate and updated information on the transport and infrastructure capabilities and on weather conditions. Among coalition partners, there is always similar equipment and assets that engaged forces could share during operations. This information is very important to reduce the footprint, eliminate redundancy, and reduce vulnerability. The similarities could be shared and negotiated among the partners through sale advisories, sharing of data, and cooperation. Planning and wargaming will be enhanced with use of new information technology tools. Enablers to help coalitions meet these needs include the following.

Logistics Data Sharing

To improve mutual logistics support, coalition members must share data.[10] These data must fit into the different logistics concepts used as models in the leading countries, such as the United States. To enhance the process among the coalition, agreements and requirements could be signed between the coalition partners. These logistics data should include areas that will emphasize coalition support. These include infrastructure, national transportation means, lines of communication, compatibility, integration of materiel, maintenance, and intransit visibility. The gathering of these data will enable the coalition to better forecast resources and deploy forces globally and rapidly at minimum expense.

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Transport Capabilities

The coalition support must be dynamic into, from, and within the theater of operations.[11] The lines of communication and environment are vital for deploying and sustaining the coalition effort, very much like the vessels that feed the brain. Perfect knowledge of the transportation system of the coalition partners and its sensitivity to the weather will increase the efficiency of the coalition's support. Transport capabilities—ground, sea, and air—of each partner and update data will help predict the flow of logistics during each phase of the campaign. The use of such capability will ease the burden on other airlift assets at less expense with regard to

maintenance and fuel costs.[12] General Carter B. Magruder, US Army, stressed the importance of the transportation as a key element to move supply and forces by saying, "If the transportation system will support, or can be developed in time to support, the forces necessary to carry out the operations plan, the rest of the logistics can usually be brought into line within a reasonable time."[13]

Similarities of the assets used to support warfighting will reduce the redundancy in equipment and personnel deployed.

Similarities

The similarities of the assets used to support warfighting will reduce the redundancy in equipment and personnel deployed. These criteria could be worked among the coalition members to plan for uniformed materiel. The Air Force is already working in this direction by choosing the joint strike force combat aircraft for all Services. Other allied countries are also interested in this purchase.

In future operations, coalition partners should work to acquire similar assets, equipment, munitions, and fuel to enhance force interoperability and coalition logistics, thus they will meet the ACS requirements.

Sales Uniformity

Sales uniformity is one of the key elements to enhance in the future to reduce the footprint and stockpile on the theater and minimize the vulnerability of coalition forces. Study and planning with coalition partners' advice and experience will help avoid mistakes when purchasing new materiel.

Uniformity of materiel and equipment among the coalition will ease the burden of the logistical support and focus on other areas. Recent conflicts showed that sharing maintenance and supply lines proved particularly helpful when US and coalition forces operated the same type aircraft.[14] The generalization of such practices in the other Services and other areas will enhance coalition support, saving time and money.

Standard New Information Technology

New information technology is the tool that will enable the coalition partners to communicate through a universal language and be understood by all logisticians. The language barriers will vanish and allow clear, safe, and secure flow of information among the coalition members. Adequate software will ease the integration of all partners'

logistical systems and speed up the process of sharing logistical data. The choice of this technology is needed. There are many examples around the world where forces are taking advantage of the use of such technology to save time and money. US forces are exploiting information technology to reduce the blatant footprint to the deployed location, improving the speed and flexibility of the logistics process.[15] The coalition should continue to leverage existing and emerging technology capabilities to enhance support.[16]

Infrastructure

Data on the architecture of the military and civilian infrastructure of each partner should be gathered, studied, and secured. These data are key to deployment, buildup of the footprint, and employment of forces. The lines of communications and their status, platforms and their characteristics, and storage facilities and their capacities are vital information that commanders use to solve coalition support equations and accommodate forces with their needs. Knowledge of the lines of communications and their status during the rainy seasons are vital to the success of coalition logistics. Lack of such information may jeopardize the safety, security, and flow of the coalition's logistics. Port and airfield platform data are necessary to prepare the deployment and sustainment of the forces. This information will enable commanders to anticipate actions and plan for successful and proactive coalition support.

Lack of such information may jeopardize the safety, security, and flow of the coalition's logistics.

Wargaming and Planning

Aggressive planning of coalition support is needed to respond to transformation and change in warfare environments, as Field Marshal Helmuth von Moltke said, "Planning is every thing—plans are nothing." Coalition logistics must keep up with these changes and meet the needs of evolving coalition forces. Diversity of the partners among coalitions will demand more efforts to plan coalition support for the future. Efforts should focus on planning, adapting of validated logistics concepts, and testing. Wargaming, using the new information technology tool, will enable partners to train to respond to crises and conflicts and will evaluate their coalition support system in play with ACS requirements.[17] During

Coalition support integration processes will learn from these examples and will evolve using high-technology tools to prove themselves and meet the future challenges.

wargaming, logistical functions will be applied with current data to optimize coalition support and reduce probabilities of failure during real time.

Coalition Support Examples

Multinational operations require the coalition support integration process to meet their needs. The partners' diversity is not easy to deal with when it comes to supporting warfare. The experience of coalition members proves such support is possible and will be beneficial to multinational operations because multinational forces always could capitalize on the unique strengths of individual members who can best provide specific support to deploying forces.[18] Pacific Command (PACOM)-Australia coalition theater logistics, North Atlantic Treaty Organization (NATO), and United Nations (UN) multinational operations are examples where the initiative of coalition support seemed to succeed to achieve and fulfill its role as Agile Combat Support. Coalition support integration processes will learn from these examples and will evolve using high-technology tools to prove themselves and meet the future challenges.

PACOM-Australia CTL-ACTD

The PACOM and Australia coalition theater logistics advanced concept technology demonstration (CTL-ACTD) project is one of the initiatives toward attaining multinational logistics, using the existing technology to meet the warfighter's needs.[19] This example will set the stage for future development in other theaters.

NATO

NATO is another example where coalition support successful in many areas. The success of the NATO CTL-ACTD project was attributed to NATO's current multinational participation and mutual agreements.

These two examples show that the buildup of coalition support is feasible because of experience and existing enabler new information technology tools, and it is necessary to respond to the increase of UN multinational operations around the world.

UN Multinational Operations

In recent conflicts, the UN used coalition forces to intervene and settle disputes between nations. These operations are different in nature, and their duration varies. Peacekeeping and humanitarian operations are among these UN interventions. To sustain these operations, the UN seeks the participation and collaboration of the coalition's logistics partners. Logistics concepts and processes are used to optimize use of such coalition support. Peacekeeping operations in Kosovo and the Congo are milestones in the history of successful coalition support. The development of these methods and their enrichment will allow coalition support to evolve to meet easily the needs of multinational forces for the settlement of peace in different regions around the world.

Coalition Support: Could It Be Shaped to Provide Agile Combat Support to Multinational Operations

Conclusion

In an era where forces are becoming expeditionary, fighting far from home among a diverse coalition, logistical support has to evolve in the same manner to meet all needs of the engaging forces and provide consistent Agile Combat Support on time, in the right place, at minimum expense. To meet these criteria, a full understanding of the coalition's logistics, its experiences, and an inventory of its fighting capabilities, locations, and transport capabilities have to be collected to fit into the same model or at least into the leading force model.

Coalition support will help establish the Lean Logistics concept, integrating an independent repair, supply, and distribution process that leverages transportation, infrastructure to reduce the deployment of people, equipment, and stocks. Such focus will lead to meet ACS milestones. As Lieutenant General William P. Hallin, US Air Force, said, "Streamlined infrastructure, time-definite delivery total asset visibility, and reduced mobility footprint are the four overarching planks of Agile Combat Support."[20]

Coalition support will help establish the Lean Logistics concept, integrating an independent repair, supply, and distribution process that leverages transportation, infrastructure to reduce the deployment of people, equipment, and stocks.

A lot of barriers have to be broken, and changes have to be made in regard to language, procedures, and policies. Through shared training, uniformed procedures, adapted laws, and reduced incompatibilities, integration of coalition logistics will be feasible and will fit to better

Geography and weather can influence the flow of logistics into the theater of operations.

serve fielded forces.[21] The aim of such coalition support is to save time, avoid stockpiles, reduce vulnerability, and minimize expenses.

Geography and weather can influence the flow of logistics into the theater of operations. Integration of these parameters in the process is helpful to predict and avoid surprises during the deployment and sustainment phases.

Coalition support is a need for future multinational operations, either to provide small-scale contingencies or a major theater war. Synergy of the coalition members' capabilities will allow coalition support to enhance rapid force deployment and precision sustainment delivery, using tailored support packages from the nearest partners.[22] The new information enablers will increase total asset visibility and improve situational awareness through information fusion. Because "Preparedness endures success and unpreparedness spells failure, there can be no victory in war without advance planning and preparations." Mao Tse-tung said such a tool will help planning and evaluating to evolve with the coalition support to lead the coalition forces to victory.

The success of such an enterprise needs a cultural shift in coalition members and their organizations without giving up their sovereignty. This change will grow, develop, and give an experienced pool of nonparochial warfighters and logisticians who embrace jointness and multinational operations just as naturally as they put on their battle dress uniforms, khakis, or a flight suit each day.[23]

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The CIRF and Beyond

Improving Agile Combat Support

Lieutenant Colonel Deborah A. Gibbs, USAF

The Air Force has transitioned from a garrison-based force in support of the Cold War to a light, lean, and tailored force highly capable of projecting power on short notice to anywhere in the world within 48 hours. "Each Air Expeditionary Force (AEF) will have the capability to project highly capable and tailored force packages, largely from the continental United States (CONUS), on short notice, to any point around the world."[1] The task for logisticians is to develop Agile Combat Support (ACS) concepts to enhance the warfighting capability of these AEFs and ensure the 48-hour *bombs on target* goal is achieved. What is Agile Combat Support and what can we do to improve it? This article defines Agile Combat Support; looks at the centralized intermediate repair facilities (CIRF) test results and implications; and discusses areas such as a rotatable engine and pod pool, transportation and forward basing, and host-nation support for possible future studies that might provide a framework for continuous improvement of logistics support to the warfighter.

Agile Combat Support

Air Force Posture Statement 2001 states:

> The goal of Agile Combat Support is to improve the responsiveness, deployability, and sustainability of combat aerospace forces. Our four basic objectives are to become more rapidly deployable; develop a more responsive planning and execution capability; improve Agile Combat Support C2 [command and support]; and develop an agile, responsive, and survivable sustainment capability.[2]

Air Force doctrine identifies Agile Combat Support as a core competency and identifies the traditional logistics functions of supply, transportation, maintenance, contracting, and logistics plans

CIRFs are wing-level maintenance facilities providing intermediate-level maintenance repair support for multiple Air Force units within a theater of operations.

as key elements. The seven interdependent core principles of Agile Combat Support are: responsiveness, rapid deployment and sustainment, time-definite delivery and resupply, effective beddown and sustainment, reachback, leveraging information technology, and efficient installation support.[3]

Centralized Intermediate Repair Facilities

During Operation Allied Force, the United States Air Forces in Europe (USAFE) Director of Logistics developed a plan to supplement the maintenance capability of forces arriving in theater. This plan became the foundation of the CIRF concept, which is to leverage existing intermediate repair facilities to meet mission requirements. CIRFs are wing-level maintenance facilities providing intermediate-level maintenance repair support for multiple Air Force units within a theater of operations. This replaces the decentralized maintenance concept in which wing-level units performed all intermediate-level maintenance for both home-stationed and deployed aircraft. There were no formal Air Force instructions, but as with other conflicts, they did what they had to, to get the job done. Following the fall 2000 Corona, the Deputy Chief of Staff for Installations and Logistics began development of a peacetime and wartime regional intermediate repair concept and test plan.[4] The test would evaluate the CIRF concept of operations (CONOPS) and analyze the logistics capacity needed to meet the AEF workload during real-world deployments.

Test plan objectives were to evaluate the CIRF capability to support steady-state or contingency operations, assess the USAFE regional supply squadron (RSS) decision authority for logistics command and control, quantify logistics footprint reduction; analyze logistics costs and spares requirements to support deployed units, and validate maintenance manpower and support equipment trigger points.[5]

The test schedule, from 1 September 2001 to 28 February 2002, involved five USAFE work centers supporting deployed AEFs and Operation Enduring Freedom. The test supported 154 deployed aircraft and

repaired 38 engines, 67 electronic countermeasure pods, 24 low-altitude navigation targeting infrared for night (LANTIRN) pods, and 170 F-15 line-replacement units (LRU).[6] The results of the test validated the CONOPS and proved centralized intermediate repair can provide consistent regional repair support during steady-state and contingency operations.[7]

ACS Implications

The ACS core principle of responsiveness is to:

> …transfer support away from a supply-oriented inventory system with large stocks of in-theater inventory to a transportation-based system that relies heavily on accurate information, time-sensitive resupply, and management tools with an array of unfailing mission support, along with cost-cutting characteristics. Key concepts are business-based management, accurate command and control, and focused depot level repair.[8]

The CIRF test, evaluating a newly developed command and control architecture for the RSS, proved successful. Personnel were able to provide the correct prioritization, induction, and distribution of CIRF assets within the European Command and Central Command area of operations. However, doctrinal command relationship issues hindered the process, and the RSS was unable to provide the anticipated C2 between J4, major commands (MAJCOM), CIRFs, and deployed units.[9] To optimize C2 spares support, a streamlined chain of command is required. The evaluation of the alignment for the RSS is necessary to ensure it has the full authority and capability to prioritize, induct, and distribute CIRF assets without bureaucratic red tape. A possible realignment of the RSS to a direct report unit of the USAFE A4 Rear and reorganization as a MAJCOM combat support center are considerations.

The CIRF test also provided improvements in theater inventory management by decreasing the size of the mobility readiness spares packages (RSP) deploying with AEFs. Shop-replaceable units and consumables required for intermediate repair are no longer required at the forward location. However, additional LRUs to plus up the RSP and ensure mission capability at the forward location are

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Support of forward deployed units is transportation-dependent and requires dedicated ground support, as well as dedicated in-theater airlift.

required. MAJCOMs will need to identify the additional requirements and fund appropriately. LRUs can be very expensive (some navigational units can cost up to $1M each), and funding constraints may make this a long-term program. In the interim, the Air Force Materiel Command could increase LRU quantities at a central location (possibly CIRFs) to meet forward-deployed requirements.

The ACS core principle of Time-Definite Delivery and Resupply is to "provide an extraordinary opportunity to achieve agility in Agile Combat Support. It lessens the need for perfectly packaged support forces by allowing combatant commanders to allocate their combat forces in the best manner to achieve mission success. Key concepts include reduced airlift requirements and providing reliable and predictable delivery of mission-critical parts."[10] This ACS principle aligns closely with Air Force Vision 2020, which states:

> We will streamline what we take with us, reducing our forward support footprint by 50 percent. We'll rely increasingly on distributed (or reachback) operations to efficiently sustain our forces, providing time-definite delivery of needed capabilities….[11]

The strategic airlift requirements for CIRF support equipment and personnel decreased significantly. An extrapolation of these data for a footprint comparison of a major theater war revealed a 72-percent personnel footprint reduction and a 100-percent support equipment reduction. These reductions are equivalent to 4.6 C-17 loads.[12] For theater airlift, "The test met the average transportation goals…[however] 30-percent individual transportation legs did not meet either goal."[13] Problems encountered meeting individual transportation legs resulted from the ground transportation of classified components and lack of transportation during weekend and holidays within the area of responsibility. The support of forward deployed units is transportation-dependent and requires dedicated ground support, as well as dedicated in-theater airlift.

The C-17 has increased in-theater airlift capabilities, but the Air Force has failed to define and develop concepts for the management of in-theater ground transportation. In the past, the Army provided the majority of in-theater ground transportation for all Services (preponderance of force), but

the Air Force mission has changed. It is now the first to the fight and may well be the service with the preponderance of force and be responsible for ground transportation in theater. This is the case in Southwest Asia. However, the Transportation Command (TRANSCOM) was unable to provide the support organically and contracted it out to local companies within the area of responsibility. This has not provided the required ground support. A foreign nationalist cannot move classified property without a US military escort, so deployed units must provide an escort to ride with the contractor. This results in lost man-hours for primary task accomplishment. It is essential to develop a viable ground transportation concept in support of AEF operations. It must provide everyday pickup and delivery of both classified and unclassified property. The easy solution may be for TRANSCOM to rent vehicles in theater and work through the AEF center at Langley AFB, Virginia, in tasking deploying units to provide military drivers. This would provide both classified and uninterrupted 7-day-a-week transportation capabilities.

The CIRF test was a success with high operational readiness, reduced logistics footprint resulting in less force protection for equipment and personnel, and reduced strategic airlift requirements. However, as indicated, there are still areas requiring study and improvement: RSS command relationships, funding of LRUs, and the need for dedicated ground transportation. A recommendation of the test was the establishment of an integrated process team to develop rotatable engine and pod pool concepts.[14]

It is essential to develop a viable ground transportation concept in support of AEF operations.

Rotatable Engine and Pod Pool

The thought behind a rotatable engine and pod pool is to minimize the time in the transportation leg for these assets. Current Air Force policy makes operational wings responsible for the funding of these assets. Even though one could argue the Air Force owns all its assets, the reality is that following the Defensive Management Review Decisions of the late 1980s and 1990s, responsibility for funding of engines and pods fell to the MAJCOMs and wings. The old axiom *possession is nine tenths of the law* fits well here. Units fund and buy their own engines and pods and will not release them for Air Force-wide

Transportation time could be reduced significantly if engines and pods became Air Force-owned and managed assets, centrally stored at a major overseas transportation hub.

distribution. Units are reluctant even to share assets with units from the other Services and normally will not unless directed by their headquarters. The way the Air Force budgets and the different *colors* of money created this nightmare. During the CIRF test, engines and pods moved from forward-deployed units through Ramstein AB, Germany (transportation node), to Spangdahlem AB, Germany, or RAF Lakenheath for repair, then back to Ramstein for air shipment back into the theater. This process was lengthy; the average customer wait time for F100-PW engines was 25.2 days, F100-GE engines 16.5 days, electronic countermeasure pods 13.9 days, and LANTIRN 16 days.[15] Transportation time could be reduced significantly if engines and pods became Air Force-owned and managed assets, centrally stored at a major overseas transportation hub. In the European theater, Ramstein AB would appear to be the ideal choice and Misawa AB or Yokota AB in the Pacific theater. This concept would provide a quick fill on a not mission capable-supply requisition. Upon deployed unit identification of a requirement for an engine or pod, the RSS would issue from the pool of assets within the central warehouse, process for shipment, and place the engine or pod in the transportation network. This would take less than 24 hours. With this scenario, the possibility exists the replacement engine or pod could arrive at the forward location before the reparable asset reaches the CIRF location for repair. This would improve Agile Combat Support and warrants further evaluation.

Forward Basing and the Requirement for Dedicated Transportation

Each pillar of ACS offers opportunities for improvements. Research and development of new strategies is ongoing. The Department of Defense is currently studying the "Futuristic aircraft, ships and other platform…as part of the US military planning for contingency operations in 2015 and beyond."[16] These futuristic aircraft may solve the transportation problems of tomorrow, but the problem facing the transporters today is providing the intratheater airlift to landlocked areas such as Afghanistan. For the last 10 months, the US military has been turning a desert strip into an airbase at Kandahar, Afghanistan.

> From bombs and bullets to tents…the transformation of Kandahar AB, and the rest of the US military's facilities in Afghanistan, has been accomplished almost exclusively by air. It's an accomplishment, experts say, that will one day be studied alongside the Berlin Airlift and Operation Desert Storm as a turning point in transportation history.[17]

The Air Mobility Command required more than 2,700 air-refueling sorties to fly more than 10,000 missions, moving almost 26,000 troops and more than 200,000 tons of cargo. This is certainly an airlift success story. However, initial flight clearances were not granted, and Air Force flights had to go south, east, and then north to get into Kandahar. This elongated route required more gas and additional tanker sorties. Eventually, the northern European sovereign nations (to include Russia) granted overflight rights, resulting in fewer air-refueling requirements. Optimally, the solution would be to have blanket clearance for overflight of all foreign nations, but this is not realistic. The solution may be to establish forward- deployed basing, a standby base, at Baku, Azerbaijan, or Ashgabat, Turkmenistan. Turkmenistan has followed a formal policy of neutrality since becoming independent but is currently providing limited support for US military aircraft refueling. Either location offers a badly needed foothold in Central Asia, fuel and airfields that could enhance en route refueling. Certainly, US investment in these areas could be a very positive step in nation building and a win-win situation. Development of host-nation support agreements is essential to document support and payment requirements.

Development of host-nation support agreements is essential to document support and payment requirements.

Host-Nation Support

The area of host-nation support has several opportunities for improvement. During Operation Allied Force, additional KC-135 aircraft (tankers) deployed into the European theater to support operational missions. The maintenance facilities at RAF Mildenhall were unable to accommodate the large influx of deployed aircraft. Upon request, the British provided facilities at RAF Brize Norton so Air Force personnel could accomplish critical KC-135 aircraft major maintenance and boom repairs.[18] The use of these facilities provided a quick turnaround on maintenance and mission-capable aircraft for sortie

The development and maintenance of host-nation support agreements provide the framework for logistics planners.

production. The alternative would have been returning these aircraft stateside for maintenance and deploying a different airframe forward. The use of these facilities on such short notice is a testimony to the international cooperation between the United States and Great Britain, but for planning purposes, it would be optimum to have it in a host-nation agreement. The development and maintenance of host-nation support agreements provide the framework for logistics planners when developing the logistics support plans for future operations and contingencies.

Conclusion

This article began with a description of the transition of the Air Force to an air and space expeditionary force and addressed the requirement for logisticians to develop new and improved ways to provide support to the warfighter. The concept of Agile Combat Support is the umbrella under which these improvements will occur. The recent development of the CIRF CONOPS and the follow-on test validated the CIRF capability to support steady-state and contingency operations, defined a command and control structure for logistics decisionmaking, and reduced the logistics footprint in the area of responsibility. However, there are several areas that will need to be addressed—such as the command relationship issues for the RSS, funding of LRUs, and dedicated ground transportation—to ensure optimum support for forward-deployed units. Dedicated ground transportation will require the development of combat support policies to provide such services when the Air Force has the preponderance of force. Additional arenas—such as the development of a rotatable engine and pod pool to minimize transportation time, storage and distribution hubs, standby basing, and host-nation support—were offered as just a few opportunities for improvement and warrant further evaluation. The job of logisticians is to provide optimum combat support to the warfighter, and one way to achieve this is through the continuous improvement of Agile Combat Support.

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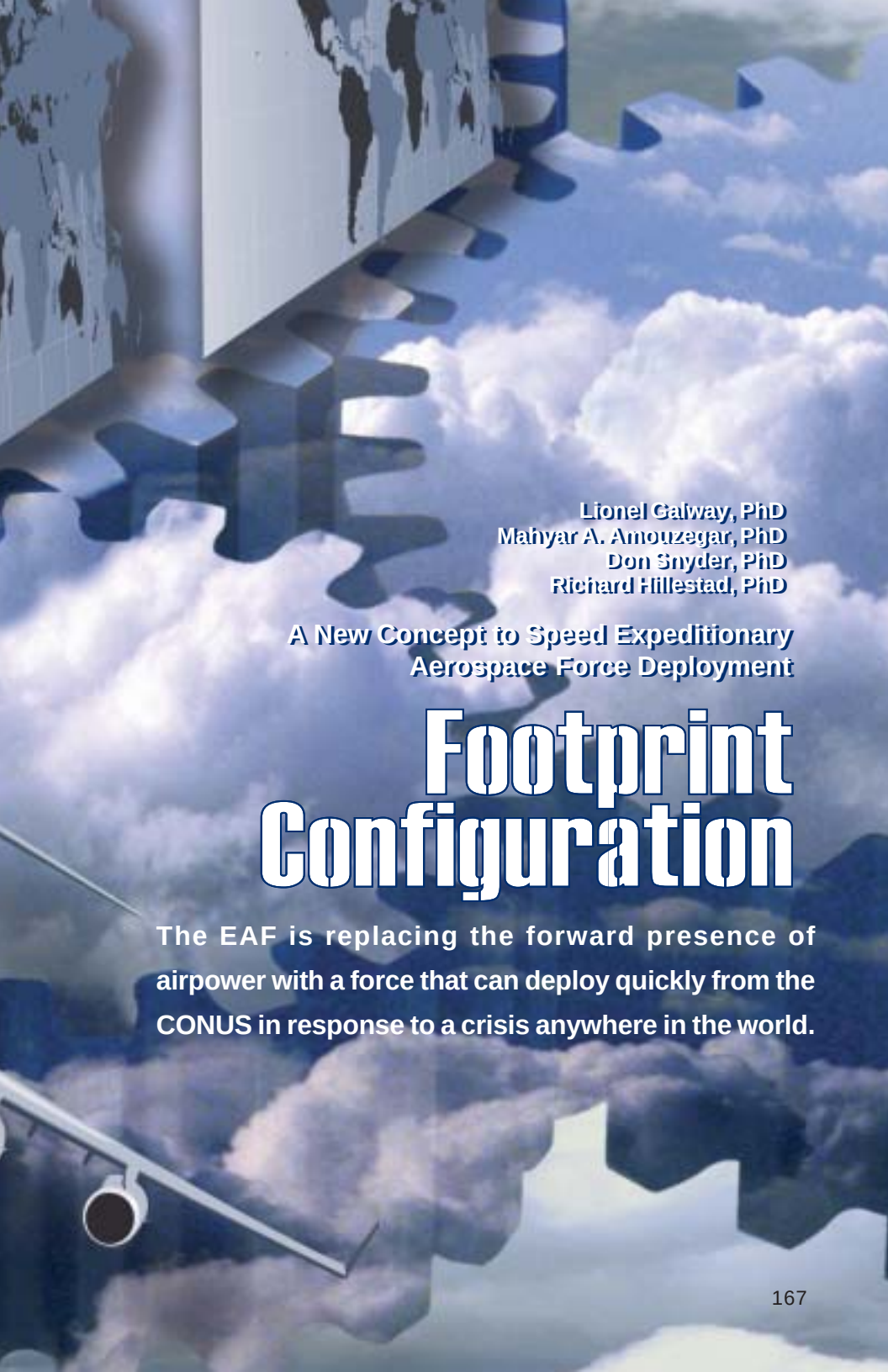

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A New Concept to Speed Expeditionary Aerospace Force Deployment

Footprint Configuration

The EAF is replacing the forward presence of airpower with a force that can deploy quickly from the CONUS in response to a crisis anywhere in the world.

A major part of deployment planning must be generic, *unlike Cold War planning that developed detailed plans for specific bases.*

From the Cold War to the EAF

Since the end of the Cold War, the Air Force has been required to perform numerous overseas deployments, many on short notice, in support of crises, ranging in size from humanitarian relief to Operation Desert Storm, and maintain a permanent presence in several areas to act as a deterrent to potential adversaries.[1] To meet these challenges, it has reorganized itself into an expeditionary aerospace force (EAF). That reorganization is replacing the forward presence of airpower with a force that can deploy quickly (within 48 hours[2]) from the continental United States (CONUS) in response to a crisis anywhere in the world, commence operations immediately upon arrival, and sustain those operations as needed. The EAF concept requires the Air Force to be able to deploy combat aircraft to bases with a range of infrastructures, from Cold War warm bases (fully equipped with prepositioned materiel and often in active use) through international airports with little military infrastructure, down to bases that have no more than water and fuel, a bare base. Further, due to uncertainties in the location and scale of future conflicts, a major part of deployment planning must be *generic*, unlike Cold War planning that developed detailed plans for specific bases.

However, quickly deploying the support structure for operations is not as easy as moving the aircraft themselves. Under current concepts of operation, all the materiel and personnel to initiate and sustain operations, the deployment *footprint*, must be present for operations to commence. The support processes constitute the major portion of any deployment, and the speed and agility of deployment hinge on the size of this logistical requirement.[3]

Given that most of the current combat platforms and their support systems were developed during the Cold War, it is not surprising that little of the support equipment was explicitly designed for rapid deployment to austere operating locations. In a series of reports, RAND and Air Force researchers examined the deployability of various specific support capabilities, including flight-line maintenance, avionics repair, low-altitude navigation

and targeting infrared for night (LANTIRN) pod maintenance, and jet engine intermediate repair, as well as munitions, fuel support, and billeting.[4] The consensus of the research was that moving all the support for an aerospace expeditionary task force (ASETF)[5] package to a forward operating location (FOL) within the notional timeframe of 48 hours was almost certainly infeasible given the current support process, organization, and equipment.

One result of this work—and of experience in Kosovo—was a call for *footprint reduction*, reducing the amount of materiel and personnel actually deployed to FOLs. According to *Air Force Vision 2020*, "We will streamline what we take with us, reducing our forward support footprint by 50%." In line with this statement of the problem, much effort and attention has been directed at the reduction of support equipment. For example, new and smaller F-15 avionics testers were developed, and new, lighter shelters and billeting equipment are being proposed. However, for many areas such as munitions, significant mass reduction will require substantial investment in new technology and development, and for some areas such as civil engineering, large reductions in the size of earth-moving equipment seem infeasible.

The primary goal in developing expeditionary support concepts is to speed the deployment of an aerospace capability so it can be employed quickly and sustained. While it is certainly plausible that there is scope for physical footprint reduction as defined above and that reduction is one important tool in achieving the deployment goal, the research previously cited and the current activities of several Air Force functional communities have recognized that the key to fast deployment is not only the physical reduction of weight but also restructuring of the footprint and time and space phasing appropriate parts of it.[6]

To include these other strategies, we need a broader concept for the size of support that can be used to analyze the time and resources needed to deploy support processes.

Footprint Configuration

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The UTC is the basic deployment unit of materiel and personnel in all branches of the military.

Beyond Footprint: Footprint Configuration

Footprint Hierarchy

The first step in examining a footprint from a broader perspective is to recognize that logistics planners work with a footprint at three different levels, illustrated schematically in Figure 1:

- Unit-type code (UTC) level: a specific support or operational capability, including both materiel and personnel
- Force or base level: all capabilities needed to initiate and sustain operations for a given force at an individual base (a set of UTCs)
- Theater level: all capabilities needed over an entire theater given a specific mix of forces and bases to perform a campaign (set of force or base packages, plus other theater support facilities)

UTC Level. The UTC is the basic deployment unit of materiel and personnel in all branches of the military. For example, the UTC 3FQK3 represents an 18-primary aircraft authorized (PAA) F-15E squadron, consisting of 449 people and 417.3 short tons of materiel. It does not include a jet engine intermediate maintenance shop, so if this is required, an HFQK3 UTC must be deployed with 40 people

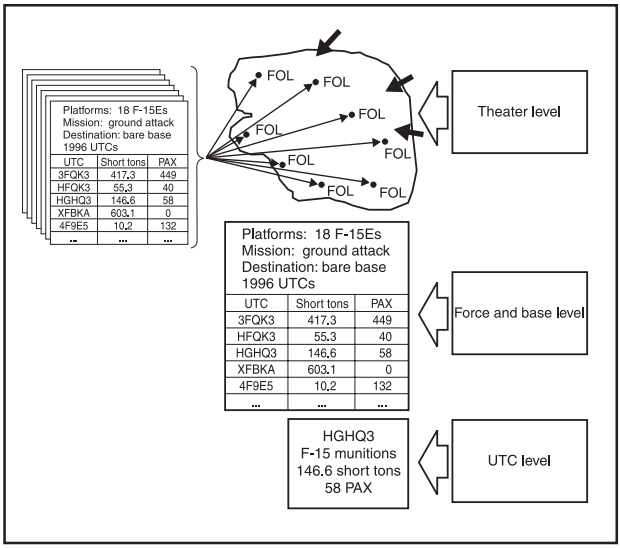

Figure 1. Footprint Hierarchy Schematic

and 55.3 short tons of additional equipment. In some cases, the entire capability of a standard UTC may not be needed, in which case the UTC is *tailored* by functional area personnel. [7]

The Desert Storm experience,[8] the development of the EAF concept, and further experience in Kosovo spurred a large-scale effort to rework all Air Force UTCs.[9] These efforts include *right sizing* UTCs (redefining standard UTCs to support smaller expeditionary forces in a range of conflicts). A parallel and complementary focus has been to break individual UTCs into modular building blocks so capabilities can be fit more precisely to specific circumstances. In addition, there are also simultaneous efforts by pilot units and functional area managers to physically reduce UTCs.

The Desert Storm experience, the development of the EAF concept, and further experience in Kosovo spurred a large-scale effort to rework all Air Force UTCs.

Force or Base Level. The second level of the footprint hierarchy, the force or base level, is the list of required UTCs that depend on the combat force and mission (for example, an 18-PAA squadron of F-15Es flying air-to-ground bombing missions), the state of the base, and the threat level.

Theater Level. The third and highest level of footprint hierarchy is the sum of all deployed materiel and personnel needed in an entire theater of operations. In the simplest case, where each base is completely self-contained, this would be the sum of individual force or base footprints. But some support capabilities and supplies can be placed in forward support locations (FSL).[10] Therefore, analysis on the theater level must take into account economies of scale that alleviate redundancies of capability among bases, create efficiencies in distribution of materiel, and reduce airlift requirements in the crucial initial phase of a deployment.

Focus on Force or Base Level

Working at either the UTC or theater level can reduce the footprint, facilitating improvements in rapid and flexible deployment. But the keystone to reducing time to deployment lies in examining the second hierarchical level: the requirements for transforming a base that does not have a full military infrastructure to one that is completely equipped to launch the required combat missions.

Understanding the requirements at a base level provides the basic data needed to plan for the capabilities and materiel that might best be positioned in FSLs to exploit economies of scale in a theater composed of many FOLs.

Evaluating the progress of footprint reduction at the base level provides a unique vantage point of the levels above (theater) and below (UTC). For example, base-level analysis will accurately assess the reduction of one UTC by jettisoning materiel available in another UTC.[11] Base-level analysis also reveals which UTCs provide the best payoff in reduction for a given expenditure of resources, rather than requiring each individual *functional* to achieve equivalent degrees of reduction. Finally, understanding the requirements at a base level provides the basic data needed to plan for the capabilities and materiel that might best be positioned in FSLs to exploit economies of scale in a theater composed of many FOLs.

Comprehensive UTC Lists for Force or Base Packages

Expeditionary force or base packages are *generic* UTC lists not tied to specific bases. Unfortunately, such UTC lists for bare bases do not seem to exist for any current or proposed force packages outside the popup aerospace expeditionary wings (AEW).[12] Although clearly *virtual*, generic lists exist in the skill base of the functional experts at major command (MAJCOM) headquarters, the lack of a canonical list of support for a given force package leaves logistics planners with few means of coordinating footprint changes on a level higher than the UTC.

It has been suggested that the various deliberate planning and historical time-phased force deployment data (TPFDD), such as those from Noble Anvil, could be used in lieu of such generic lists. While such efforts provide valuable insight for the construction of generic lists, in general, these data are not adequate for strategic logistics planning. First, very few of these deployments are to true bare bases, so they do not directly answer the question of defining the total package required to support any given force. Further, for each historical or planned base and force package, there are specific circumstances and assumptions unique to each situation that must be taken into account.[13] In most cases, drawn from planning data, each base has prepositioned materiel and assumptions about resources available on the local economy in that specific location.

Finally, many of the UTCs in either deliberate planning or in historical data are heavily tailored.

The EAF will have to develop the capability to assemble lists of UTCs for different force packages to deploy to any operating location. The determining parameters would also include components of destination infrastructure and threat level, among others. Such capability-based lists could be used for strategic planning of transportation resources, a starting point for footprint changes (identifying large UTCs that are natural candidates for reduction or restructuring, accounting for materiel shifted out of one UTC to another without acknowledging that no total reduction has been achieved), and a template against which deliberate and crisis planning for specific locations could be compared.

Footprint Configuration

Footprint configuration provides a framework for visualizing and assessing the broader array of strategies for decreasing the deployment time line.

Footprint configuration provides a framework for visualizing and assessing the broader array of strategies for decreasing the deployment time line.

FOL Versus Remote Support Processes. Researchers have observed that support processes[14] can be divided into those that must be done at an FOL from where aircraft fly and those that can be done remotely, either at FSLs or even at CONUS support locations.[15] The footprint in terms of equipment (or personnel) can, therefore, be initially divided into two pieces as illustrated in Figure 2.

The FOL Segment. The FOL segment can, in turn, be subdivided into the following three pieces, as shown in Figure 3:

- The initial operating requirement (IOR) is required at the FOL to initiate combat operations.
- The follow-on operating requirement is needed at the FOL to sustain combat operations at the desired tempo.

Figure 2. Division of Footprint into FOL and Remote (Not at FOL) Pieces

Footprint Configuration

IOR for munitions would consist of an initial stockpile of munitions, fins, and fuses, plus the munitions assembly and movement equipment.

- The on-call segment is required at an FOL only in specific circumstances and is deployed only when needed.

For example, the IOR for munitions would consist of an initial stockpile of munitions, fins, and fuses, plus the munitions assembly and movement equipment. The follow-on requirement, in this case, would be the resupply of munitions necessary to continue carrying out operations. The on-call category can be specialized fuses that can be used only for a very specific mission.

The Remote Segment. The remote segment can be subdivided further into two pieces as in Figure 4.

- FSLs are facilities that can support FOLs with selected maintenance or supply processes linked to the FOLs by intratheater transport.

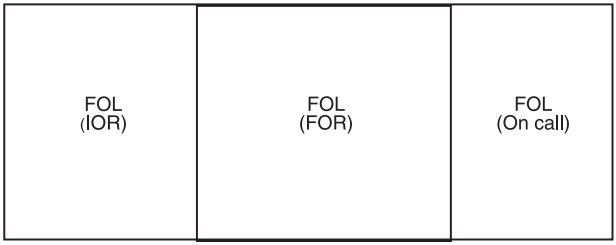

Figure 3. Subdivision of FOL Footprint Portion into Initial and Full Operating Requirements and On Call

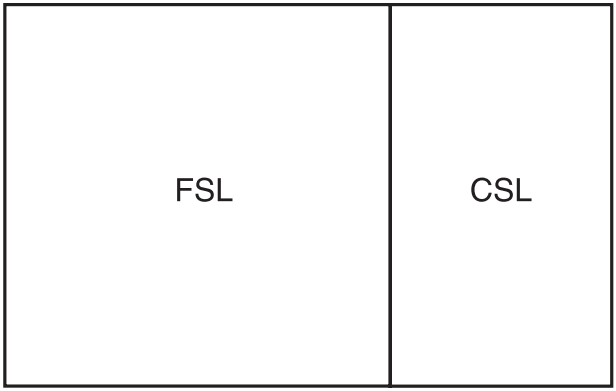

Figure 4. Subdivision of Remote Footprint Portion into Subdivisions at Forward and CONUS Support Locations

- CONUS support locations are support facilities in the CONUS linked to FOLs by using intertheater transportation.

FSLs were established during the Kosovo conflict as centralized intermediate repair facilities at locations such as Royal Air Force Lakenheath and Spangdahlem Air Base, Germany, to support FOLs in Italy and Turkey with avionics and engine repair and phase maintenance. Currently, many F-16 avionics line-replaceable units are repaired by CONUS facilities no matter where the aircraft are located around the world.

Many F-16 avionics line-replaceable units are repaired by CONUS facilities no matter where the aircraft are located around the world.

Putting It All Together: Footprint Configuration. Putting these subdivisions together gives a time and space phasing of the different segments of this process in this potential configuration. Figure 5 is a comprehensive picture of what is prepositioned (shaded region), what needs to be moved and when, and what need not be moved at all for this process.

We have presented the discussion this far in terms of a single-support process. However, the real interest is in combining all support processes into a force or base package as shown in Figure 6.

Some processes may be required to be entirely at the FOL, with no part that can even be on call (for example, notional support process B). Others may not have any part at a CONUS support location (process E), while for others, the proportion in each segment may vary, along with what can be prepositioned. But the real value is that it provides a framework for explicit decisions about what parts of individual support processes need to be moved and, if they do, when they are needed. The concept of footprint

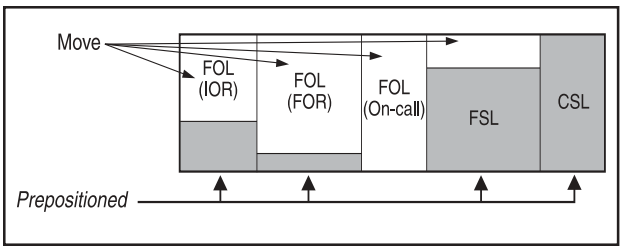

Figure 5. Footprint Configuration for a Notional Individual Support Process

Footprint Configuration

Footprint configuration also recognizes that different process configurations can interact, either at the force, base, or theater level.

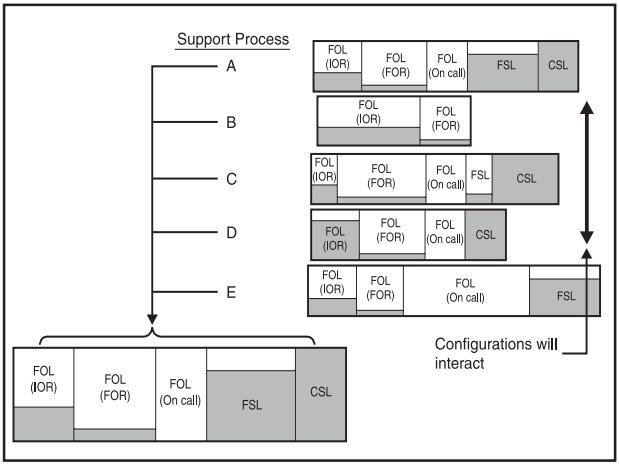

Figure 6. Combining Footprint Configurations for Multiple Support Processes

configuration also allows for the traditional reduction in weight and personnel while encompassing other strategies.

Footprint configuration also recognizes that different process configurations can interact, either at the force, base, or theater level. If an FSL can be established with robust transportation for jet engine intermediate repair, then an FSL for avionics at the same location can use the transportation links already established. So in making decisions about how to reconfigure a process, all levels of the footprint hierarchy need to be considered.

Evaluating Footprint Configurations: Metrics

Because the basis of footprint configuration is to structure support process arrival across space and time, the characteristics of footprint configuration are multidimensional.

There are four primary metrics:

- Time to IOC
- Time to FOC for the desired capability
- Transportation resources required to move the IOR
- Transportation resources required to move the follow-on operating requirement[16]

Achieving desired values on these four metrics requires trading off or controlling several other key metrics:

- Materiel mass and personnel moved.
- Cost—investment and operating costs are both important.
- Flexibility—is the configuration chosen capable of supporting different kinds of operations under varying circumstances? Too much prepositioning could reduce the flexibility to use other FOLs.
- Risk—there are a series of risk analyses that need to be done for any configuration, including risks of depending on transportation; the vulnerability of FOLs with prepositioned materiel and centralized facilities; and political, cost, and technical risks.

For many of these metrics, input from the operations side of the Air Force will be required. How much flexibility is needed and how much can be traded for speed and robustness? Which risks are acceptable and which are unacceptable? What is IOC and, hence, IOR? What are the missions and operational rates needed? The close linkage between operations and logistics required by expeditionary operations presents a new challenge for the Air Force.[17]

The close linkage between operations and logistics required by expeditionary operations presents a new challenge for the Air Force.

Developing and Evaluating Alternative Footprint Configurations

When there are a number of different metrics and goals to be simultaneously satisfied, inevitably, there will have to be tradeoffs and compromises.[18] First, we need to be sure all aspects of support are accounted for. This is the role of parameterized UTC lists discussed previously. Second, for any proposed configuration, we need the capability to evaluate defined metrics (and any additional ones deemed necessary). Third, we need to be able to rank and weight the metrics so we can make tradeoffs for decisionmakers for alternatives based on the metric values (for example, some high costs may be paid to get a substantial decrease in deployment time). The primary focus should be on evaluating key force or base combinations since these are the fundamental building blocks of expeditionary deployments.

Footprint Configuration

An evaluation tool can allow decisionmakers to modify the deployment list by selecting new or alternative UTCs or by allowing pieces of UTCs to be time phased, prepositioned, or deployed to an FSL instead of an FOL.

Evaluating Force or Base Packages

Building on the list of UTCs for a given force or base package, an evaluation tool can allow decisionmakers to modify the deployment list by selecting new or alternative UTCs or by allowing pieces of UTCs to be time phased, prepositioned, or deployed to an FSL instead of an FOL. Such decisions would change the ultimate package deployed and would be reflected in the key metrics of time to IOC and deployment resources computed by the tool. Figure 7 shows the notional structure of the broader tool. A set of requirements models for different support processes sits at the center (and interacts) so that changes in personnel in one support area, for example, are reflected in billeting. Requirements parameters (force and mission characteristics, technological changes, and so forth) are inputs to the model, and the outputs are the size and movement requirements.[19]

After evaluating different configurations, a selection must be made about which configuration (choice of FSL functions, prepositioning, technological development) will be implemented. To identify a configuration that performs well across the multiple

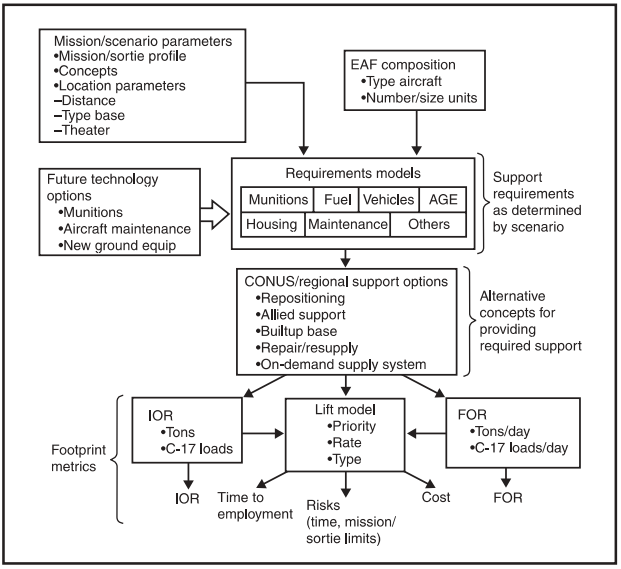

Figure 7. Evaluation Tool for Force or Base Package

metrics proposed, the RAND-developed DynaRank Decision Support System[20] could be used. This tool, an EXCEL add on, is a scorecard-development tool, which allows the user to specify a hierarchy of metrics and options to be compared. Scorecard manipulation functions allow multiple options to be sorted, ranked, and displayed by individual metric performance or aggregate weighted performance as selected by the decisionmaker (who, thus, has control over which metrics are most important).

For the near future, the two most important types of base infrastructures are the warm base and the *international airport* type base. Current planning suggests the following force packages are the most important for fighter operations:

- Full squadrons of F-15Es (ground attack), F-16CJs (Suppression of Enemy Air Defenses), and either or both F-15s and F-16s for air-to-air
- The *canonical* ASETF: 12 each of F-15Es, F-15Cs, and F-16CJs, for a small, balanced package of capability
- A six-ship, single-mission design series package of F-15s and/or F-16s for air-to-air[21]

Attention is focused on the strategic problems of expeditionary support, not on details of specific bases and units.

The combination of the two base infrastructures with the force and mission packages above should provide a comprehensive view of how well the Air Force could carry out expeditionary operations over a wide spectrum of situations. One final point of emphasis: this evaluation should be done in terms of *generic* deployments, not specific ones. In this way, attention is focused on the strategic problems of expeditionary support, not on details of specific bases and units.

Evaluating Individual UTCs and Theater Configurations

Most of the work in reengineering and reconfiguring specific UTCs will reside with the functional area experts at the MAJCOMs and pilot units. In most cases, evaluating UTCs will be diagnostic to help identify promising areas of research for improving the performance at the force or base level. For example, initially, interest might focus on the heaviest UTCs: munitions, civil engineering, Harvest Falcon, and vehicles. High-technology areas such as medical and communications are also important to track

Some critical support processes are not *organic to the Air Force.*

because of the ongoing opportunities for technology insertion.

Some critical support processes are *not* organic to the Air Force, such as ground-based air defense and theater missile defense. However, these systems can be heavy and, by our definition, are part of the support of an airbase in that they are required, in some circumstances, to commence and sustain operations. It may, therefore, be in the interest of the Air Force to track their deployability as well.

Operational commanders and support planners at the theater level are interested in the deployment and beddown of a large force at multiple sites throughout a theater and being prepared for several different scenarios. However, with the force or base level understood (including the presence of theater-level facilities such as FSLs), evaluating and tracking the theater-level performance of footprint configurations is then a matter of aggregating the performance at the relevant individual bases.

Recommendations

- **Adopt the concept of footprint configuration as an organizing principle for restructuring support processes.** By being able to organize all the strategies in a common framework with a clear set of metrics, the selection of appropriate strategies for individual support processes will be clearcut and rigorous.
- **Develop parameterized UTC lists to generate a comprehensive list of UTCs needed to deploy given force capabilities to different base infrastructures.** This capability is central to expeditionary planning in that it allows evaluation of speed of deployment for a range of forces and destinations.
- **Exercise more centralized control of UTC development.** Because there is a primary global metric and deployment time and different support processes have different sizes and reconfiguration options, we believe more centralization to direct and evaluate efforts is important. Currently, most of the responsibility for making process changes resides at the pilot unit for each UTC. While involvement of process experts is critical, there needs to be central oversight of the allocation of the reengineering effort because the goal is the deployment of a complete force package.[22]
- **Evaluate changes in deployment speed and other major metrics for selected force packages and base infrastructure combinations to track progress.**

- **Set up a system to aggregate the force or base evaluations to theater level for current warplans and for strategic support planning for proposed plans.** As with the force or base evaluations, this would evaluate changes in deployment speed, time to IOC, and deployment resources but theater-wide plan for basing and employing expeditionary forces. In the current defense structure, these evaluations are clearly of interest to the MAJCOMs supporting the several geographic combatant commanders, who would probably wish to set up their own tracking systems based on actual theater plans. But recent events, such as the operations in Kosovo and Afghanistan, have indicated many major operations will draw operational forces and support from several combatant commanders, so corporate tracking to evaluate all warplans for review, as a whole, by senior Air Force leadership may be an emerging necessity. As with coordinating UTC development centrally, this will be a move toward a more centralized overview of a support system that is increasingly seen in global terms.[23]
- **Develop tools to help decisionmakers evaluate and select among alternative footprint configurations.** Such tools, together with the parameterized UTC lists advocated above, would allow analysts to evaluate many different footprint configurations quickly and rigorously. Because we do not expect there to be a configuration that dominates in all metrics simultaneously, decisionmakers also will need to organize the results of evaluating different configurations to allow them to weight the results of individual metrics to come to a final decision. This is in line with the view that logistics must become a *strategic* planning function in an expeditionary world.[24]

Recent events, such as the operations in Kosovo and Afghanistan, have indicated many major operations will draw operational forces and support from several combatant commanders.

Notes

1. Bill Sweetman, "Expeditionary USAF Sets Course," *Jane's International Defense Review*, Vol 33, May 00.
2. US Air Force, *Vision 2020: Global Vigilance, Reach, and Power*, Washington DC, 2001.
3. Lionel A. Galway, Robert S. Tripp, Timothy L. Ramey, CMSgt John G. Drew, *Supporting Expeditionary Aerospace Forces: New Agile Combat Support Postures for the EAF*, RAND, Santa Monica, California, MR-1075-AF, 2000.
4. See, for example, Tam T. Vo, *Exploratory Analysis of the Deployment Feasibility of United States Air Force Air Expeditionary Forces*, Air Force Institute of Technology, Wright Patterson AFB, Ohio, Sep 97; Frank C. O'Fearna, *Reduction of the Aircraft Ground Equipment: Footprint of an Air Expeditionary Force*, master's thesis, AFIT/GOR/ENS/99M-14, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, Mar 99; Galway, et al, 2000; Robert S. Tripp, Lionel A. Galway, Timothy L. Ramey, Mahyar Amouzegar,

and Eric L. Peltz, *Supporting Expeditionary Aerospace Forces: A Concept for Evolving to the Agile Combat Support/Mobility System of the Future*, RAND, MR-1179-AF, 2000; Eric Peltz, Hyman L. Shulman, Robert S. Tripp, Timothy Ramey, Randy King, and John G. Drew, *Supporting Expeditionary Aerospace Forces: An Analysis of F-15 Avionics Options*, RAND, Santa Monica, California, MR-1174-AF, 2000; Paul Killingsworth, Lionel A. Galway, Eiichi Kamiya, Brian Nichiporuk, Timothy L. Ramey, Robert S. Tripp, and James C. Wendt, *Flexbasing: Achieving Global Presence for Expeditionary Aerospace*, RAND, Santa Monica, California, MR-1113-AF, 2000; Amatzia Feinberg, Hyman L. Shulman, Louis W. Miller, and Robert S. Tripp, *Supporting Expeditionary Aerospace Forces: Expanded Analysis of LANTIRN Options*, RAND, Santa Monica, California, MR-1225-AF, 2001; and Mahyar A. Amouzegar, Lionel Galway, and Amanda Geller, *Supporting Expeditionary Aerospace Forces: An Analysis of Jet Engine Intermediate Maintenance Options*, MR-1431-AF, 2001.

5. Terminology surrounding the expeditionary aerospace force (EAF) has changed over the 5 or so years of its existence. As it stood during research reported here, EAF denoted the overall operational concept, AEFs were the ten subdivisions of Air Force forces (two of which are on call at a time), and ASETF was used for whatever force was actually being deployed. Subsequently, two units were designated to initially handle very fast deployments, and these were designated AEWs. However, the acronym AEF was originally used for the deploying force, and it is possible that an entire on-call AEF would be deployed for a major conflict. In this document, we will use ASETF for the deploying force.
6. For examples of Air Force functional thinking, see "Civil Engineer Expeditionary Combat Support," AF/ILE, briefing dated 24 Jul 00, and "Medical Aspects of Dispersed Expeditionary Operations," ACC/SG, briefing dated 1 Apr 01. For a review of similar Army thinking, see Eric Peltz, John Halliday, and Steven Hartman, "Combat Service Support Transformation: Emerging Strategies for Making the Power Projection Army a Reality" (forthcoming), RAND, Santa Monica, California.
7. Jeffrey M. Hess and Merry D. Wermund, *Analysis of Standard Type Unit Development*, Thesis, AFIT/GLM/LSM/92S-23, Air Force Institute of Technology, Wright-Patterson AFB, Ohio, 1992.
8. In Operation Desert Storm, it was noted that many Air Force UTCs arrived with as much as a 40-percent increase in personnel and a 300-percent increase in equipment over their nominal values and, further, some UTCs did not have their stated capability. See Stephen J. Hagel, "Capturing Logistics Data, Part II," *Air Force Journal of Logistics*, Air Force Logistics Management Agency, Maxwell AFB, Gunter Annex, Alabama, Vol 16, Winter 1992.
9. Briefing, "United States Air Force UTC Refinement Effort," AF/XOXW, undated.

10. See Robert S. Tripp, Lionel A. Galway, Paul S. Killingsworth, Eric L. Peltz, Timothy L. Ramey, John G. Drew, *Supporting Expeditionary Aerospace Forces: An Integrated Strategic Agile Combat Support Planning Framework*, RAND, Santa Monica, California, MR-1056-AF, 1999, and Killingsworth, et al 2000.
11. For example, the medical community initially elected to drop power generation capability from its expeditionary facilities in the expectation of hooking into the bare base power grid. However, the latter was being reduced because it was assumed several functional areas had their own power sources. See *Bare Base Annual Report 2000*, ACC/LGXW, 1 Dec 00, Rev A 26 Dec 00.
12. The 366th Wing, Mountain Home AFB, Idaho, is one of the popup AEWs charged with being ready to deploy instantly to a warm base worldwide. As part of its planning process, the 366th has developed a list of 120 plus UTCs to augment the support resources at a generic warm base and expects to use the list as a template TPFDD to be completed when it actually deploys.
13. For example, total deployment figures for bases used in Operation Noble Anvil do not shed much information on resources needed to commence operations, and they may be contaminated by the *Poppa Bear* buildup (in which resources but not aircraft were deployed). Also, the TPFDD for Operation Noble Anvil also may not include some intratheater movements in Europe carried out by civilian transport.
14. In this project, we focused on support processes, but much of the subsequent discussion holds true for the operational part of the footprint as well.
15. Peltz, et al, 2000, and Galway, et al, 2000.
16. Unless these are feasible (in the sense of being acceptable to the theater combatant commander or CINC) under a variety of circumstances, expeditionary aerospace forces will not be used.
17. Tripp, et al, 2000.
18 Galway, et al, 2000, and Tripp, et al, 2000.
19. Tripp, et al, 1999.
20. Richard J. Hillestad and Paul K. Davis, *Resource Allocation for the New Defense Strategy: The DynaRank Decision-Support System*, MR-996-OSD, Santa Monica, California, 1998.
21. This stems from the parallel interest of the Air Force for dispersed operations. See the output of the Dispersal Conference, 20-21 Feb 01, in Washington DC, sponsored by AF/XOX.
22. Hess and Wermund.
23. Tripp, et al, 1999.
24. Tripp, et al, 2000.

Dr Galway, Dr Amouzegar, Dr Snyder, and Dr Hillestad are members of the research staff of the RAND Corporation, Santa Monica, California.

Transporting Munitions

History and Relevance to Expeditionary Airpower

Major Kirk L. Kehrley, USAF

Throughout history, great armies have successfully used a transportation infrastructure to create their greatest asset—mobility for their expeditionary forces. The forces of Alexander the Great, the Ottoman Empire, Napoleon Bonaparte, and Ulysses S. Grant successfully used their own or their host nation's transportation infrastructures to enhance mobility. Their successes occurred because they had an efficient means of transportation and transportation infrastructure with which to be supplied. In contrast, during World War II, the German Army could not be resupplied during Operation Barbarossa, thus denying the mobility on which the blitzkrieg was based. Air Force leadership for the aerospace expeditionary force (AEF) must understand how a host nation's transportation infrastructure affects munitions flow to the warfighter.

A responsive transportation system, integrating commercial and military modes, must be considered and evaluated. Operation Allied Force proved movement of US munitions is dependent on a host nation's transportation infrastructure. The lessons learned from historical applications of a transportation infrastructure necessary to support munitions movements can be applied to today's AEF.

Logistics was the basis of Alexander the Great's successful strategy. It was the most responsive and flexible force in existence because of its small logistics footprint. Philip, Alexander's chief logistician, ensured the troops carried their own arms, armor, and some provisions while marching, compensating for the lack of a transportation infrastructure. Oxen and oxcarts were not used. Oxen could achieve a speed of only 2 miles per hour, their hooves were unsuitable for carrying goods for long distances, and they could not keep up with the army's daily marches, which averaged 15 miles per day. The army did not use carts or servants to carry supplies, as was the practice of contemporary Greek and Roman armies; horses, camels,

Transportation routes used to bring supplies were guarded heavily; their primary purpose was to ease the passing of marching troops and animals to the storage depots.

and donkeys were used in Alexander's baggage train because of their speed and endurance. As necessary, roadbuilders preceded the army on its march to keep the planned route passable.[1]

Alexander depended on host-nation support to keep the routes his armies traveled open and protected, very much like is called for in the Joint Vision 2020 doctrine of multinational operations.[2] While marching through arid areas, such as present-day Greece and Turkey, Philip provisioned depots throughout regions where grain and water were not available. To enable this, Alexander secured the alliance of people along the route who would be responsible for supplying the depots and protecting the routes his army would use.[3] Transportation routes used to bring supplies were guarded heavily; their primary purpose was to ease the passing of marching troops and animals to the storage depots.

Many of these same ancient roads are still in use today, some even with the original engineering infrastructure. One such bridge, the Saint Julien, was constructed by the Romans in the 3d century BC in the Provence region of present-day southern France and spans the Coulon River. To this day, the bridge supports normal vehicle traffic. As archers' missiles evolved to the use of cannons in the 14th century, even well-built roads and bridges, such as the Saint Julien, could not quickly accommodate heavy-footprint items like cannons.[4] However, the Ottoman Empire overcame this handicap in the 15th century.

The Ottoman Empire

The Ottoman Empire, which reached its zenith in the 16th century under Sulaiman the Magnificent, stretched from North Africa to Hungary and from the Aral Sea in the east to the Caspian Sea in the west. Similar to Alexander's strategy, the key to conquering an area that size was the mobility of its army. A French traveler in the 14th century characterized the mobility of Ottoman troops with, "They can start suddenly…. When the drum sounded, they put themselves immediately to march, never breaking step, never stopping till the word was given. Lightly armed, in one night, they travel as far as their Christian adversaries in three days."[5] Even with the use of heavy cannons, the army could move quickly, unencumbered by the heavy

logistics footprint of munitions because it created a special cannon corps to manage its munitions program.

Cannons of the mid-15th century created a challenge to mobility, and as a result, their use was initially resisted by the Ottoman cavalry.[6] These bronze cannons typically were 12 to 15 feet long with diameters of 30 inches or greater.[7] Under the reign of Murat II (1402-1451), the Ottomans created a cannon corps, known as the *Topçu Ocaðý*, to manufacture and use cannons. Murat II's son, Mehmed II, established a cannon wagon corps, known as *Top Arabacý*, to transport arms and munitions during campaigns. Additionally, a specialized fleet of boats carried cannons. Foundries were built in different parts of the empire.[8] The Ottoman cannons, powerful enough to knock down the walls of Constantinople during a 53-day siege in 1453, were cast outside the city walls.[9] The furnaces and molds to make the cannons were placed outside the walls, and the raw materials were brought there.[10]

In terms of transporting firepower, the Ottomans moved 80 ships overland from the Bosphorus Sea to the Golden Horn to get a better strategic fighting position for the siege of Constantinople—the transition of the fleet allowed them to subject Constantinople to siege from any side. The Golden Horn was the waterway that served as the city's harbor and was protected with metal chains, preventing the entrance of the Ottoman fleet. Mehmed II's engineers built a road that rose 200 feet above sea level, upon which was laid a track of greased timbers. The ships were pulled out of the water and laid on metal-wheeled cradles. Teams of men and oxen pulled the entire 80-ship flotilla 1,400 feet overland from the Bosphorus to the Golden Horn.[11] Thus, whether lightly armed or bearing heavy cannons or foundry equipment, the Ottomans delivered the firepower necessary to build an empire.

Napoleon and Transportation Infrastructure

Like the Ottomans, Napoleon Bonaparte created a munitions transportation infrastructure. The mobility of the Napoleonic armies was tied to the mobility of their supporting munitions infrastructure. In his book, *Essai Général de Tactique*, written in 1772, Comte de Guibert's

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When Napoleon went to war against Austria, he ushered in a new logistics concept of constant resupply by supply convoys.

vision of battlefield mobility greatly influenced Napoleon Bonaparte. De Guibert wished to end the practice of private contractors' delivering supplies from rear magazines to armies on the march. He believed supply controlled a general's movements because he was ignorant of the working of the supply system. "It is a fundamental error to separate the science of subsistence from the science of war."[12] He stressed that army officers should learn supply.[13]

De Guibert proposed a reduction in the weight of artillery to increase its mobility. His goal was to allow the troops to have the maximum firepower with their mobility so they could be directed at a weak point and overcome the enemy.[14] De Guibert advocated mobile field artillery because large quantities of artillery and support for them hindered an army's mobility.[15]

In 1805, when Napoleon went to war against Austria, he ushered in a new logistics concept of constant resupply by supply convoys. In a matter of weeks, he assembled a supply and transport system for a 170,000-man army. Similar to Alexander, Napoleon's staff sent dispatches to cities along the proposed routes to secure provisions and supply the army along the way. Through Heilbronn, Germany—possibly the first recorded munitions depot in Western warfare—flowed 75,000 to 100,000 rounds of ammunition during the Austrian campaign. In addition to the munitions depot at Heilbronn, Napoleon had a military transportation system, consisting of wagons and boats, to move the munitions needed to support the artillery; he allocated 2,500 of 4,500 wagons to support the artillery. In 1807, Napoleon replaced hired vehicles and drivers with fully militarized transportation personnel and equipment.[16]

Grant and the Necessity of Surface Transportation

In terms of transportation infrastructure, one has only to read the Civil War dispatches of General Ulysses S. Grant. His concern for transportation infrastructure is summed up in the first paragraph of his report of the US Armies 1864-1865 to E. M. Stanton, US Secretary of War. Grant relayed (despite the numerical inferiority of the Confederate Army):

> The resources of the enemy and his numerical strength were far inferior to ours; but as an offset to this, we had a vast

> territory, with a population hostile to the government, to garrison and long lines of river and railroad communications to protect, to enable us to supply the operating armies.[17]

Grant knew resupply of the Union expeditionary campaigns depended on Confederate-controlled rails, roads, and water ports.

According to Grant, if the South could have prolonged the war, it would have won with a stalemate. "In the North, the people governed and could stop hostilities whenever they chose to stop supplies."[18] To bring the war to an end, Grant planned to have continuous operations of his forces "regardless of season or weather;" therefore, he needed to continuously supply his forces.[19]

Grant planned to have continuous operations of his forces "regardless of season or weather;" therefore, he needed to continuously supply his forces.

Grant knew that roads, railroads, and rivers were centers of gravity around which the Civil War revolved. Railroads became the military roads for both armies, and special garrisons were established to protect them.[20] In February 1862, General D. C. McCallum was appointed Military Director of Railroads, with authority to take possession of railways and engines required for the transport of US troops, arms, and military supplies. The ordnance supplied for the Union came from arsenals, foundries, and armories throughout the North, incidentally located on railroads and waterways.[21]

In terms of transportation infrastructure, Major General Rufus Ingalls, Union Chief Quartermaster of the Armies operating against Richmond, stated, "In order that the enormous streams of supply may be uninterrupted, the wagon roads should be of the best construction, drained, hard and smooth."[22] Ingalls also outlined how to use the roadways to maximize logistical support.

Ingalls relayed that, at Gettysburg, all wagon trains were assembled at Westminster, approximately 25 miles to the rear. Only ammunitions wagons and ambulances were brought up to the immediate rear lines. The established priority for moving mule-driven supply trains was, "Wagons containing small-arm ammunition coming first and then those containing the ordnance, subsistence, and forage…."[23]

Grant's goal was to have his wagons never operate more than a single day's march from their supply depots, usually at railheads or river ports. Speaking of the Army of the

Grant's goal was to have his wagons never operate more than a single day's march from their supply depots, usually at railheads or river ports.

Potomac in 1864, he said "Too much credit cannot, therefore, be awarded to the quartermaster and commissary departments for zeal and efficiency displayed by them."[24]

In terms of the importance of munitions to the Confederacy, a law was enacted requiring any ship that entered a Confederate port to have arms or ammunition else it would be confiscated. Referring to Confederate soldiers, Captain Henry G. Sharpe wrote in 1896, "Though the soldiers were often barefoot, ragged, and hungry, they never lacked arms, nor were they defeated for want of ammunition."[25] Nearly all Confederate States established munitions factories under the exclusive control of the Confederate Government.[26]

Grant's dispatches clearly show the importance of a transportation infrastructure to the Union and the Confederacy. In a dispatch to Major General Sheridan during the Shenandoah Valley campaign in October 1864, he said, "If you make the enemy hold a force equal to your own for the protection of those thoroughfares, it will accomplish nearly as much as their destruction."[27] The thoroughfares he refers to were the Virginia Central Railroad and canal. In the Shenandoah Valley campaign to capture the railroad, Grant said, "This road was very important to the enemy. The limits from which his supplies had been drawn were already very much contracted, and I knew he must fight desperately to protect it."[28] In another example, Grant knew the importance of the Danville railroad to General Robert E. Lee as Grant advanced on Five Forks, Virginia, prior to the battle at Gettysburg. He knew that by pressuring the Danville railroad Lee would fight. "These roads were so important to his very existence while he remained in Richmond and Petersburg, and of such vital importance to him in the case of retreat, that naturally he would make most strenuous efforts to defend them."[29]

The Road Known as the Sacred Way—Verdun, France, 1916

Roads are not normally associated with the static trench warfare of World War I; however, the road from Bar-le-Duc to Verdun, known as the *Voie Sacrée* or Sacred Way, was a 50-mile lifeline for the French during the 10-month siege

of Verdun. It was at Verdun that General Erich von Falkenhayn convinced the German Kaiser he could bleed the French to death. To understand the importance of Verdun to the French, remember that two-thirds of the whole army passed along it bound for Verdun.[30] As one passes through this picturesque Lorraine region today, various monuments dot the Sacred Way from Verdun to Bar-le-Duc. A sign on one of the monuments indicates that in 9 months 2.4 million men and 1 million tons of munitions were moved down this vital artery. In June 1916, at the peak use of the Sacred Way, more than 12,000 vehicles deployed through it, one vehicle passing through every 14 seconds.

Roads are not normally associated with the static trench warfare of World War I.

To bleed the French to death at Verdun, the Germans concentrated on logistical support for artillery. They planned to use their heavy guns to blast a hole in the French lines and then send in their infantry.[31] Prior to the first shot fired on 21 February 1916, the Germans had stockpiled 2.5 million shells, some 3,000 for each artillery battery.[32] On the plateau leading up to Verdun, the German Fifth Army built more than 10 railway lines and 24 new stations. Seven spur lines were built in the Spincourt Forest to provision the heavy guns the Germans would put there. The largest German guns were the 422-millimeter mortars or Big Berthas. The shell was as tall as a man and weighed more than a ton. It took 12 wagons to transport one of the immense guns and 24 hours to put it together once its destination was reached.[33] A crane was required to load the shell in the gun tube.[34]

The Roads of a Blitzkrieg

In his 1937 book, *Achtung Panzer* (Attention Armor), General Heinz Guderian gave insight into how vital tanks and supporting armor vehicles would be in the conduct of future wars to avoid the attrition of World War I trench warfare.[35] He was the principal architect behind the infamous blitzkrieg strategy.

Guderian was convinced that tanks could not be successful without logistical support. Thus was born the idea of armored divisions to provide the support that allows tanks to fight to their maximum capacity.[36] However, during the creation of the German Armored Force,

The key to the blitzkrieg was the army's ability to be mobile.

Guderian's request to motorize heavy artillery battalions was turned down. In his memoirs, he remarked, "The heavy guns remained horse-drawn, with unfortunate results during the war, particularly in Russia."[37]

The key to the blitzkrieg was the army's ability to be mobile, similar to the vision of De Guibert. Guderian stated, "Only movement brings victory."[38] The emphasis for the tanks was appropriately pushed, but not the logistics infrastructure to support them. As early as 1937, Guderian noted that resupply of Panzers was found to be insufficient during validity exercises. He noted that rapid movement of supplies and repair depots were needed.[39]

During Operation Barbarossa, the invasion of Russia, German logistics was based on *Grosstransportraum* (truck-carrying capability) in which trucks would supply the Panzers. Robert Kershaw, author of *War without Garlands*, described a 500-kilometer logistics tripwire, which indicated the limit of logistics sustainability for the Panzer advance. After 500 kilometers, only rail could ensure acceptable logistics support. However, 500 kilometers was too long; the trucks the Germans used, of which approximately 40 percent were captured French vehicles, were in poor mechanical condition at the outset of Barbarossa. The Panzers rapidly outpaced the foot army, which relied on horse-drawn transport. It was calculated that 1,600 trucks were needed to equal one double-track railway over a 500-kilometer distance. German rail troops had to convert Russian rail to German gauge. After approximately 3 weeks into Barbarossa, 480 kilometers of rail had been completed, but it had only one-tenth the carrying capacity of German rail because of ground structural supports.[40]

During Barbarossa, Guderian and Adolf Hitler spoke of the importance of seizing Moscow because it was "the great Russian road, rail, and communications center."[41] The German Army General Staff anticipated defeating the Russians in 8 to 10 weeks. In Barbarossa, Guderian's center of gravity was the establishment of a decent supply route to resupply his Panzer forces.[42] Unlike Alexander the Great or Napoleon, Guderian could not provision his fighting forces at advance depots using host-nation support.

Additionally, he described the importance of capturing road and rail centers to serve as a base to fight from as the

campaign continued. General Guderian stated, "We could only move as fast as our supply situation would allow."[43] During the advance on Moscow, Guderian said corduroy roads had to be laid down for miles for his troops to be supplied.[44] Grant, 79 years before, had also remarked that corduroy roads had to be laid in order for his army to advance on Corinth, Mississippi.[45] The Third Panzer Division had to be resupplied totally by air. Besides fuel, munitions, clothes, and food, even the salve for the Panzer's telescopic sights did not arrive, which made the tank guns useless. "If only we were mobile and had our old combat strength, then it would be child's play. The Russian is trained and equipped for winter warfare, and we are not."[46]

When Guderian recommended to Hitler that the Germans withdraw from Russia, he was told to dig into the ground where they were and hold every inch of land. Guderian replied that the troops could not dig into the ground because it was frozen to a depth of 5 feet. Hitler then retorted to blast craters with heavy howitzers. Guderian responded that he did not have sufficient explosives even to blast out defensive positions.[47] Lack of a German transportation infrastructure was further exacerbated by the lack of a local area road or rail. Unlike Alexander or Napoleon during his Austrian campaign, the Germans had no host-nation support to secure bases within their adversary's country in which to establish supply depots.

Unlike Alexander the Great or Napoleon, Guderian could not provision his fighting forces at advance depots using host-nation support.

Operational Allied Force and Lessons Learned about Transporting Munitions

In peacetime, the significance of many elements of wartime logistics and administration are not apparent; consequently, officers can be lulled into a false sense of security insofar as these matters are concerned.

—Rear Admiral Henry E. Eccles

The Air Force transformation to an AEF parallels the expeditionary forces of Alexander the Great, the Ottomans, Napoleon, Grant, and Guderian. As with these armies, AEF mobility is dependent on a responsive transportation system or coalition partner to enable rapid transport of warfighting materials. AEF

AEF involvement in Operation Allied Force clearly showed the criticality of transportation to project airpower—especially in terms of munitions.

logisticians must be able to respond rapidly to support a mobile combat force in multiple planned and unplanned locations. AEF involvement in Operation Allied Force clearly showed the criticality of transportation to project airpower—especially in terms of munitions. Moving munitions presents a tremendous challenge to logisticians because of their bulk, wide variety, and the immense quantities required to support modern air operations. Munitions dominated the logistics footprint during Operation Allied Force. Many items can be purchased from a warfighting coalition partner, including large footprint items such as fuel; this is not the case with munitions. During Operation Allied Force, US foreign military sales (FMS) of $35M were generated, mostly in selling munitions to our allies.[48]

At the onset of Operation Allied Force, the United States Air Forces in Europe (USAFE) munitions infrastructure was evolving from a fight-in-place to an expeditionary concept. In 1989, USAFE had 57 munitions storage areas and an established fight-in-place operations plan with clear stockpile objectives. By 1999, USAFE had 20 percent of its 1989 stockpile and 24 percent of its 1989 storage capacity spread out in only 14 munitions storage areas. Stockpile guidance was vague, and while the force was still in the drawdown mode, Operation Allied Force provided an opportunity to evaluate the munitions infrastructure necessary to support an air expeditionary air force. In Operation Allied Force, USAFE munitions logisticians projected munitions to nine different locations, had multiple changes in munitions requirements, and coordinated numerous country clearance issues.[49]

One of the great lessons learned from Operation Allied Force was that a host country's commercial infrastructure, particularly transportation, was the linchpin to US logistics in the European Command (EUCOM) area of responsibility. EUCOM is in a coalition warfare scenario and requires the munitions throughput capability that only our allies can provide. On the other hand, Thomas Friedman, in a 3 February 2002 *New York Times* editorial, stated American technology is destroying the North Atlantic Treaty Organization (NATO) alliance. He believes, as a result of being more technologically advanced than

its NATO allies, America does not need them to fight a war.[50] Unfortunately, Friedman does not realize how much America relies on the NATO allies' rail and trucking industries to move its munitions.

As Grant pointed out, in referring to the North, "Supplies can be cut off by the whim of the people," so can the whim of our coalition partners hinder or totally cut off our supply lines, which are dependent on the coalition's infrastructure.[51] Flexible transportation is critical because large quantities of munitions must be positioned even though a proportionately small amount will be expended. Target sets and the type of ordnance can change on a daily basis. In Operation Allied Force, 35,000 short tons of munitions were moved, but only 6,000 short tons were actually expended.[52] Munitions accounted for 47 percent of the combat support and sustainment logistics footprint in Operation Allied Force.[53] Integrating commercial and military transportation modes is normal during any munitions move (aside from direct air-force-to-air-force airlift). Currently, USAFE evaluates its own infrastructure, such as explosives-sited holding areas or the number of war reserve materiel shipping containers necessary for theater-wide munitions shipments. However, USAFE does not evaluate a host nation's infrastructure throughput for US munitions, even though the critical area is the host nation's transportation of these assets. For example, explosives-licensed, long-haul drivers; security; country clearance; stevedore unions; explosives-sited docks; and explosives-sited rail marshalling areas are unique capabilities for which the United States depends on its host nation for Agile Combat Support. Restrictions such as transportation on weekends, local police rules and regulations, and overland and overflight clearance were different in each country the Air Force dealt with during Operation Allied Force.[54] Additionally, explosives restrictions existed at host-nation seaports, railheads, railways, highways, and the munitions beddown locations.[55]

Flexible transportation is critical because large quantities of munitions must be positioned even though a proportionately small amount will be expended.

When these variables do not exist, logistics workarounds may increase the throughput of needed munitions. For example, during Operation Allied Force, the seaport at Trapani, Sicily, was located adjacent to US aircraft; however, permission was not given to use the port. To

Logistics workarounds may increase the throughput of needed munitions.

supply US aircraft near Trapani with munitions, an air bridge was established using C-130s from Ramstein Air Base, Germany. For 2-1/2 weeks, an average of three C-130s flew in 28 short tons of munitions each day, enabling the wing to carry out its mission until permission was granted to use another seaport sufficient to download munitions.[56] The port finally used was at Empadocle, Sicily, more than a 4-hour drive from the port at Trapani. Additionally, munitions ships were limited to 100,000-pounds net explosives while berthing at the harbor.

In another instance, the USAFE munitions staff did not anticipate much munitions movement to support B-52s at Royal Air Force (RAF) Fairford, England, because of the 500- and 2,000-pound bombs already at RAF Welford and RAF Lakenheath. However, the B-52s requested 750-pound bombs (M117). The USAFE munitions staff commenced to source 18,000 from the CONUS. Ironically, from 1992 to 1998, the USAFE munitions staff had sent to salvage more than 11,000 M117s that were in the USAFE stockpile.[57]

Additionally, in May 1999, as a result of projected B-52 drops of Mk-82s, the USAFE munitions staff knew they would run out before resupply from the CONUS. The staff worked to move more than 5,000 from US stockpiles in Norway and used them to fill the gap until resupply could be accomplished from CONUS.[58]

Operation Allied Force required a flexible transportation system to swing munitions wherever they were needed on short notice. Munitions forecasting was a challenge in Operation Allied Force; therefore, a robust transportation system that could react quickly to changing munitions needs was necessary. The USAFE Munitions Directorate developed a munitions authorization and allocation plan for every fighter and bomber unit in the theater by using the standard configuration load (SCL) for each aircraft. The SCL was combined with the Crisis Action Operations Center and a target set to develop a validated plan that became the standard for munitions resupply during Operation Allied Force. From this plan, the USAFE Munitions Directorate developed a munitions storage plan for a 5-day munitions requirement for each combat wing. Of the eight operating locations supported with munitions, only three were capable of storing enough

munitions to sustain a 5-day requirement by the combat wings at those locations. This meant constant resupply and movement of much ordnance.

To source munitions, logisticians must have sufficient lead time to coordinate country clearance issues and contract transportation (sealift, airlift, or surface) to ensure the right types of munitions are available for aircraft when they arrive at their forward operating location. In Operation Allied Force, during the anticipated bed down at sites in Turkey, the specific aircraft MDS was not identified until approximately a week out from aircraft arrival. Air-to-air assets were typically flown from Ramstein, whereas laser-guided bomb components (seeker head and tail kit) could be either flown in or downloaded from an afloat prepositioning ship in the area.

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The potential setbacks at Empadocle, Fairford, and Turkey were offset because Operation Allied Force benefited from working within a theater that had, in most cases, a strong commercial transportation system. Turkish, Italian, Norwegian, British, and German Allies moved 460 railcars, uploaded and downloaded 7 coaster ships, and operated 1,042 transport trucks to deliver munitions to 8 different beddown locations during Operation Allied Force. [59]

Since the first recorded drop of munitions in 1911 from an Italian airplane over Turkish troops in Libya, the technology of the munitions dropped from airplanes has evolved; however, the 500-pound bomb dropped in World War II is still that, a 500-pound bomb.[60] Technology has improved the accuracy and possibly reduced the quantity of bombs necessary, but the weights have not decreased. During Operation Allied Force, 35 percent of the munitions dropped were precision-guided, compared with 8 percent in Operation Desert Storm. In our present era of precision-guided munitions, the general-purpose 500- and 2,000-pound bombs, standardized in 1941, still weigh the same but now have different tail kits or seeker heads.[61] It is not fair to assess that precision-guided munitions will reduce the munitions footprint. In fact, the containers for the tail kits and seeker heads make the logistics footprint even larger. We may be seeing an increase in killable targets, but the numbers of munitions may not be reduced as first thought.

In Operation Allied Force, the US European Command (USEUCOM) transportation system was not stressed.

Despite the challenges to the movement of munitions, Operation Allied Force was a light challenge to the munitions logistics transportation system: it took 78 days, and 6,600 tons of munitions were expended. During Desert Storm, ten times that amount were expended in less than half the time. In Operation Allied Force, the US European Command (USEUCOM) transportation system was not stressed. The Army was not engaged, leaving the Air Force, in most instances, full access to the otherwise joint-use transportation resources possessed by US Allies.[62]

How USAFE Is Applying Operation Allied Force Lessons Learned

As a result of lessons learned during Operation Allied Force, the USAFE Munitions Directorate created the Theater Munitions Distribution System (TMDS) to create flexibility for munitions distribution by establishing regional munitions hubs in the north, central, and southern regions of the USAFE area of responsibility (AOR). The hubs were chosen because they had the requisite storage, maintenance, and transportation capabilities of the remaining USAFE bases necessary to stage, repair, and swing munitions to any fight worldwide. The hubs are RAF Welford; Ramstein Air Base; and Camp Darby, Italy. The existing munitions infrastructure and storage capabilities at RAF Welford, along with the outstanding civil trucking and seaport capabilities in Great Britain, make it an ideal location. Ramstein directly supports European operations and provides worldwide support through its airlift capability. Its railhead and truck outload points improve the ability of the United States to stage and move ammunition to and from explosives-sited seaports.

Camp Darby helps support munitions supply for all combat operations south of the Alps. More than half the munitions dropped in Operation Allied Force were shipped from there.[63] It gives the United States tremendous munitions throughput capability and is the only munitions storage area in the entire European AOR with both an explosives-sited water dock and railhead located adjacent to the munitions storage area. The only other US munitions storage area with an explosives-sited seaport adjacent to it is at Kadena Air Base, Japan.

The munitions infrastructure planned under TMDS directly supports joint movement of munitions. The US Army, Europe would benefit directly from Ramstein and Camp Darby for its mission to project land power through the planned storage, staging, and transportation infrastructure. Likewise, Naval Forces, Europe can take advantage of all munitions hub port improvements to facilitate seapower. NATO coalition forces can enjoy the same benefits as US forces for munitions movements through efficient implementation of foreign military sales.

Finally, TMDS helps minimize host-nation challenges. By regionally positioning munitions, we can minimize the number of country clearance activities during coalition warfare. This also gives us the opportunity to establish modes for munitions transport, enabling US forces to fully inform sovereign nations of planned munitions movements; allows concerns to be voiced prior to potential conflicts; and permits USEUCOM to mitigate national concerns before they become serious. TMDS establishes the means and methods to ensure the success of coalition warfare.[64]

NATO coalition forces can enjoy the same benefits as US forces for munitions movements through efficient implementation of foreign military sales.

Conclusion

For the Air Force to remain mobile and have a truly expeditionary aerospace force, it must realize that coalition warfare is dependent on our partners, who control stevedores, trucking companies, and rail and seaport networks. It must pay attention to the admonishments of Eccles and De Guibert: officers must not be ignorant of their logistics system. This article does not advocate that leaders and tacticians become logisticians; it advocates that munitions logistics be a key planning factor. In particular, the movement of US munitions, within a host nation or from anywhere on the globe, is contingent on the understanding of host-nation transportation infrastructures and that host nations actually will be transporting US munitions. Coalition warfare is transportation-dependent. The United States cannot perform its mission without considering coalition partners in its Agile Combat Support logistics model. For the foreseeable future, munitions expenditures by US aircraft will dominate any coalition warfare in which the United

The United States cannot perform its mission without considering coalition partners in its Agile Combat Support logistics model.

States participates. In an earlier *Journal* article, "AEF Munitions Availability," the authors stated, "To meet the munitions challenges of EAF, the Air Force must look for ways to improve rapid transportation capabilities, infrastructure, and prepositioning support."[65] Operation Enduring Freedom confirmed that the Air Force must heed this advice. As we review the history of a munitions transportation infrastructure, we can focus on one main point—successful military commanders throughout history have concentrated on the transportation of munitions to support the mobility that made their fighting forces successful.

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We shall not fail or falter; we shall not weaken or tire...Give us the tools and we will finish the job.

Sir Winston Churchill, BBC radio broadcast, Feb 9, 1941

I found Rome a city of bricks and left it a city of marble.

Caesar Augustus, from Suetonius, Augustus

A billion here, a billion there, pretty soon it adds up to real money.

Senator Everett Dirksen

Faith in the ability of a leader is of slight service unless it be united with faith in his justice.

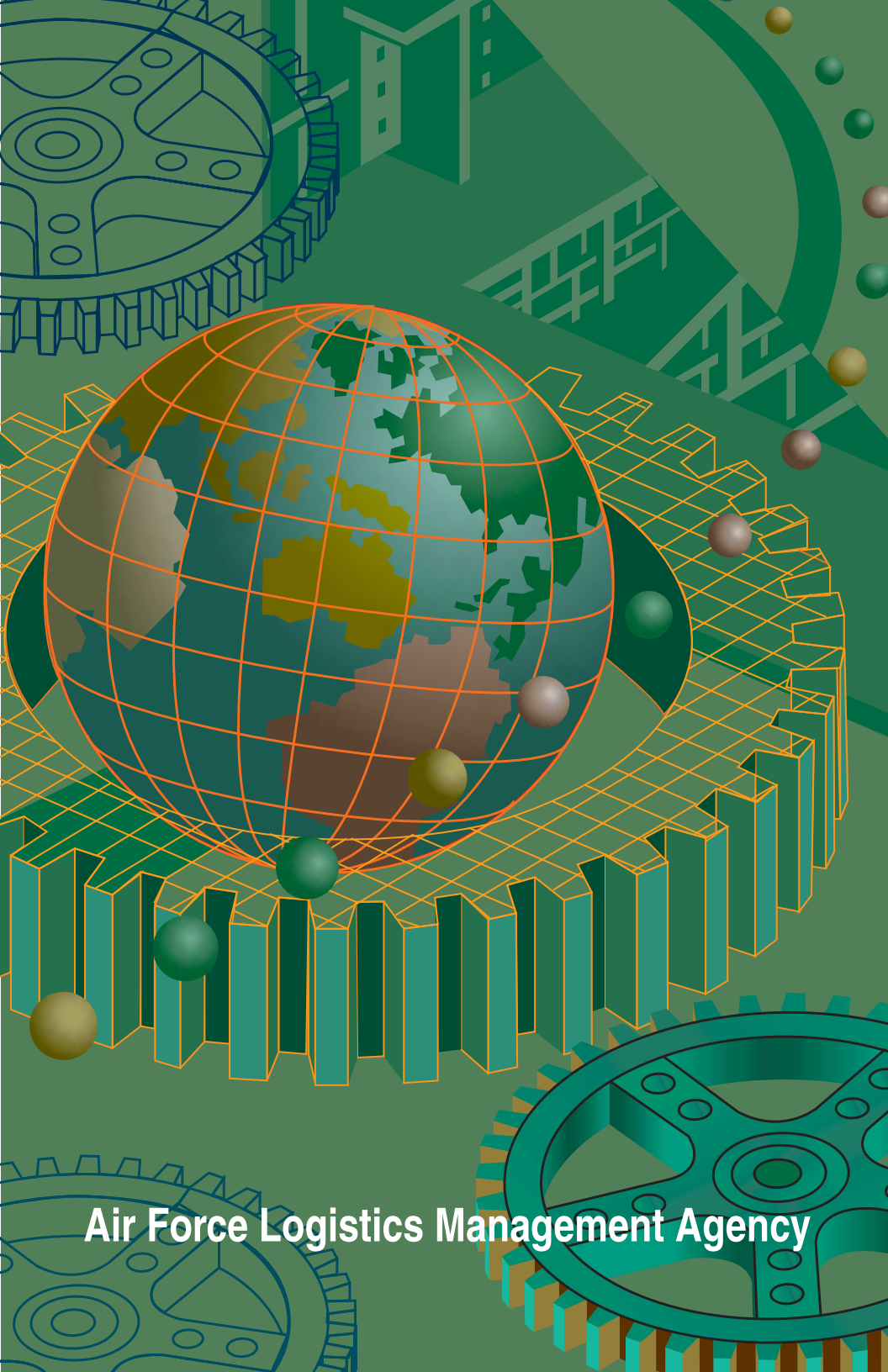
George Goethals

The art of war is simple enough. Find out where your enemy is. Get at him as soon as you can. Strike him as hard as you can, and keep moving.

Ulysses S. Grant

We confide in our strength, without boasting of it; we respect that of others, without fearing it.

Thomas Jefferson


Air Force Logistics Management Agency