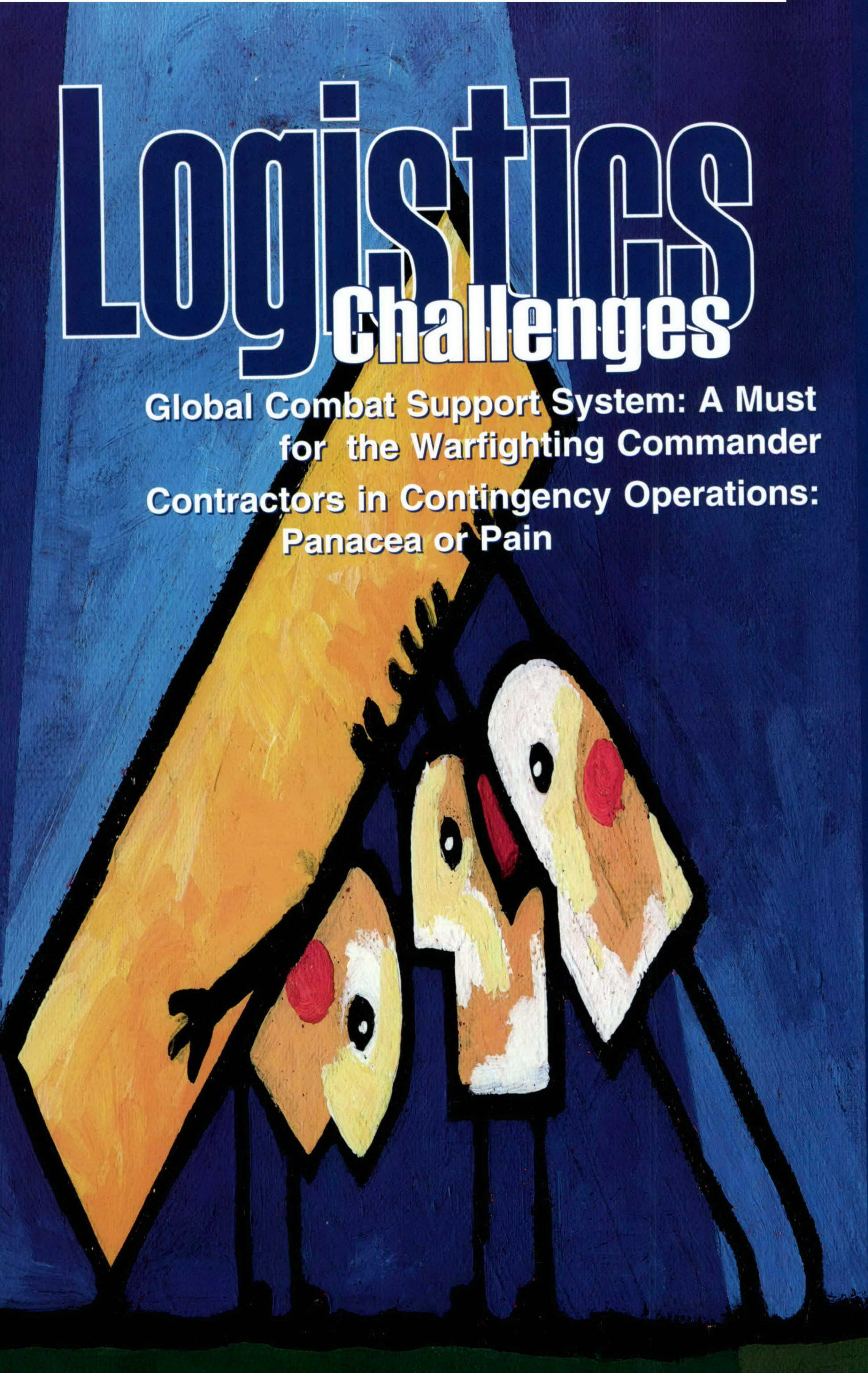

Logistics Challenges

Global Combat Support System: A Must for the Warfighting Commander

Contractors in Contingency Operations: Panacea or Pain

JL

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Special Feature

In today's environment, US forces have been called on to make numerous overseas deployments, many on short notice—using downsized Cold War legacy force and support structures—to meet a wide range of mission requirements associated with peacekeeping and humanitarian relief, while maintaining the capability to engage in major combat operations such as those associated with operations over Iraq, Serbia, and Afghanistan.

logistics challenges

Global Combat Support System: A Must for the Warfighting Commander

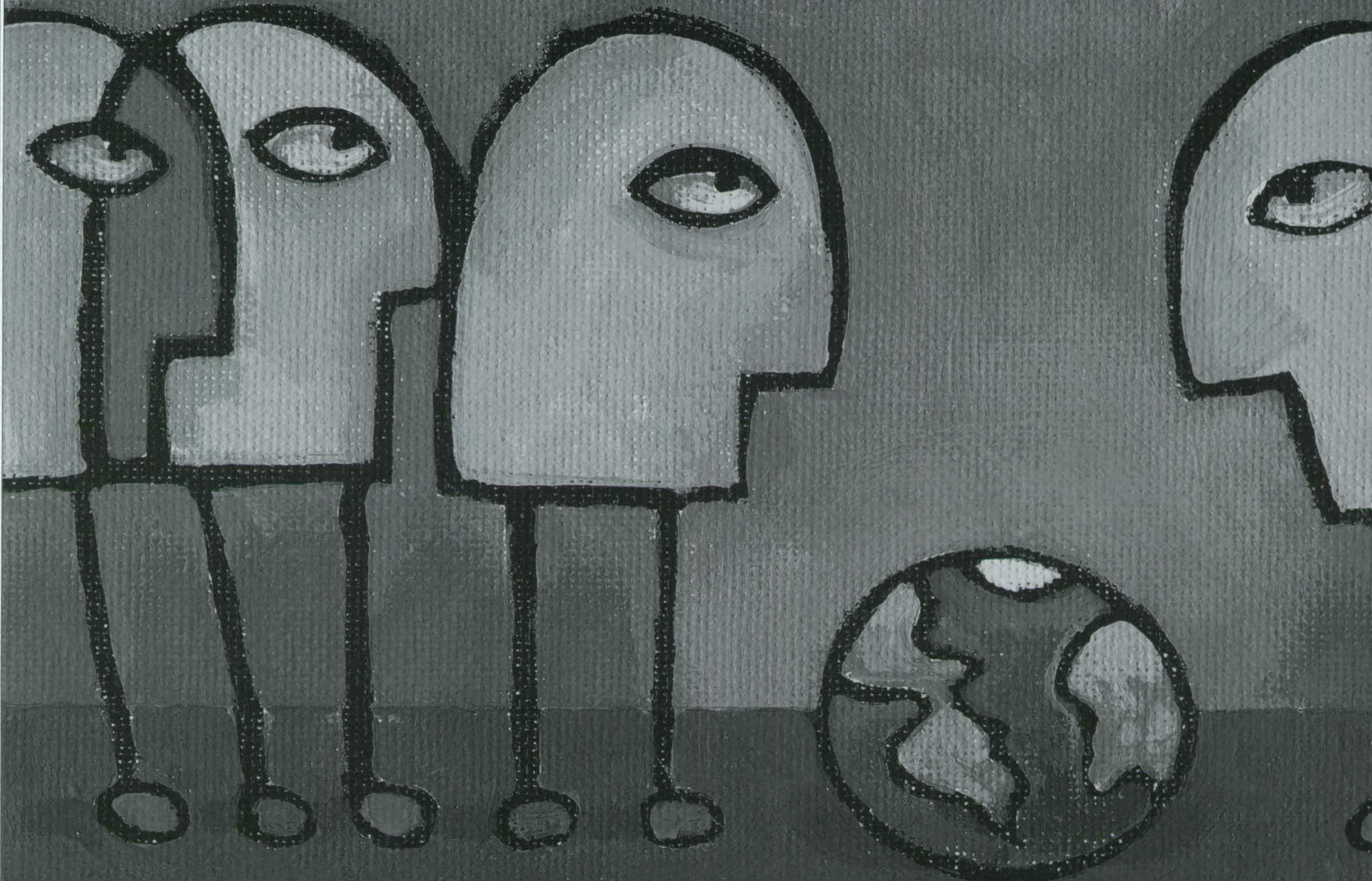
Contractors in Contingency Operations: Panacea or Pain

The dramatic increase in deployments from the continental United States, combined with the reduction of military resource levels, has increased the need for effective combat support. Because CS resources are heavy and constitute a large portion of the deployments, they have the potential to enable or constrain operational goals, particularly in today's environment, which is so dependent on rapid deployment. Central to solving the CS equation is streamlining CS deployment processes, leaning deployment packages, evaluating technologies that speed deployment, and the need for logistics management systems that keep pace with the evolving nature of war. Newkirk and Currie in "Global Combat Support System: A Must for the Warfighting Commander" argue for the need to link the network-centric warfare concept to logistics and for selection of a logistics management system that fully integrates requirements.

The history of contractor support for the US military can be traced to the Revolutionary War. Some level of contractor support has been a fact of life through all the major and minor conflicts of the 19th and 20th centuries. However, since the Vietnam conflict, contractors have been called on to perform work that directly supports military missions—work that increased their presence near or on the battlefield. This has led to significant issues—contractor status, service doctrine, contract versus organic capabilities, host-nation support contracts, and actual money and manpower savings. "In Contractors in Contingency Operations: Panacea or Pain?" Manker and Williams examine these issues and draw a variety of conclusions.

Global Combat Support System

A Must for the Joint Warfighting Commander



Based on lessons learned from military operations since Desert Storm and the asymmetric nature of future battlefields, DoD leaders have determined that a joint, network-centric warfare focus will guide the military's efforts to transform its forces.

Lieutenant Colonel Bryan T. Newkirk, USA
Colonel Karen W. Currie, USAF

Introduction

Special Feature

Providing the very best supply support to the joint warfighting commander requires that logisticians get the right supplies and equipment, in the right quantities, in the right condition, at the right place, at the right time.[1] Throughout the history of warfare, management systems that logisticians have used to provide the best supply support have changed and will continue to change. As a result of lessons learned from previous conflicts and continuous technological advances to improve warfighting capabilities in future wars, logisticians have been required to find new logistics management systems to keep pace with the evolving nature of war. Using logistics lessons learned from Operations Iraqi Freedom and the Department of Defense's (DoD) specific guidance for departments and agencies to develop network-centric systems for use on tomorrow's information age battlefield, logisticians can develop a reasonable list of required capabilities for the new supply management system that will be used to support the joint warfighting commander in the future. However, the current dilemma within the DoD logistics community is not identifying requirements for this future system but selecting a supply management system that best meets the requirements.

The Network-Centric Warfare Concept Applied to Logistics

Based on lessons learned from military operations since Desert Storm and the asymmetric nature of future battlefields, DoD leaders have determined that a joint, network-centric warfare focus will guide the military's efforts to transform its forces.[2]

What is this network-centric warfare concept, and what does it look like when applied to logistics? Network-centric warfare effectively links or networks geographically dispersed semidependent joint forces operating in an unpredictable environment against a sophisticated adversary who uses asymmetric strategies. This network provides each joint force with real-time, common, actionable, battlespace information. The real-time actionable information enables each force to reorient based on shared information, make decisions based on common goals, and then act at rates previously unattainable. Unlike raw information that must be analyzed before a commander can use it, this actionable information is analyzed already and tells commanders actions to take to best support the warfighter. Ultimately, network-centric warfare greatly reduces decisionmaking and execution time lines, resulting in increased flexibility, lethality, and speed for the warfighter.[3]

Given DoD's emphasis on transforming the US military into a network-centric warfare fighting force, the Office of the Secretary of Defense (OSD) has chartered the Office of Force Transformation (OFT) to take the lead with the transformation of the military. OFT has emphasized that network-centric operations incrementally integrated into the military will be coevolutionary. In other words, there must be a continuous development of mutually supporting strategies, concepts, processes, organizations, and technologies as the system is being fielded in DoD. Development will be based on feedback from the field and testing at designated experimentation sites.[4]

When applied to logistics, the network-centric concept produces a logistics concept that the OFT calls sense and respond logistics (S&RL).[5] This is a logistics concept in which current service, unit, and DoD agency materiel stovepipes are crossed, allowing the free flow of supplies among units, services, and supply depots. The S&RL or network-centric logistics concept provides a common global asset visibility picture to all users and commanders and automatically directs the most effective and efficient movement of supplies from anywhere within the global network to satisfy real-time demands. All units in the network are potential sources of supply to all other units. Additionally, the DoD's joint concepts document has mandated that the network-centric logistics concept be a joint endeavor that gives US forces the ability to fight, not as independent services relying on supplies within their stovepipes but as truly joint and interdependent forces that rely on and have access to supplies anywhere in the DoD enterprise.[6] Supplies are triggered on real-time demands, the operational scheme of maneuver, supply priorities, and parameters established by authorized commanders. The system is highly adaptive to support frequent changes in supply requirements.[7] It focuses on continually enhancing warfighting unit readiness, which requires that the logistics network-centric system have seamless and continuous interaction with the joint warfighter's operational and intelligence networks.[8] Interaction with these networks will have a direct effect on warfighting unit readiness and supply requirements information in the logistics domain. The OFT also has directed that network logistics systems be coevolutionary. This means that network-centric logistics component systems must be fielded incrementally in DoD and then immediately modified based on feedback from the field and designated experimentation sites. Additionally, the new logistics system must have all the following attributes:

- Take advantage of the best models by continually leveraging the capabilities of commercial and government technology.
- Be readily modified so that it always takes advantage of the latest technological developments and is interoperable with emerging DoD information network architecture.
- Be ready for immediate use in the DoD enterprise.[9]

In summary, the OFT has determined that the network-centric logistics or S&RL system must meet these four critical requirements:

- Provide a common global asset visibility picture of all materiel in the DoD network.
- Continuously recommend the most effective and efficient move of supplies from anywhere in the network to satisfy real-time demands.
- Establish common logistics objectives and direct supply and transportation units to release and move supplies based on those common objectives and recommendations in capability number two above.
- Be ready for immediate use and be easily modified so that it always leverages the best government and commercial technology.

The emerging DoD system that has potential to evolve and become the very best network-centric logistics enterprise for the Armed Forces is the Global Combat Support System (GCSS).

The Global Combat Support System

To develop one logistics asset visibility system that would meet user requirements across the DoD enterprise, OSD initiated the GCSS project in 1996. The GCSS operational concept that identified system capabilities, organizational support requirements, and the flow of information within the system was completed in 1997 and has been updated frequently since then. The Logistics Directorate of the Joint Staff (JSJ4) is responsible for GCSS architecture development. Various offices support the JSJ4 in its efforts to provide direction, priorities, contractor support, and oversight.[10]

When applied to logistics, the network-centric concept produces a logistics concept that the OFT calls sense and respond logistics.

Today, the Defense Information Support Agency (DISA) has fielded base models of GCSS in each of the geographic combatant commander's theaters. DISA's incremental fielding of modules with new capabilities gradually will enable GCSS to meet most of OFT's network-centric logistics requirements by 2006.[11] The current version of GCSS in the Central Command's (CENTCOM) theater during Iraqi Freedom allowed the CENTCOM Logistics Director (J4) to make prudent supply management decisions that joint staffs could not make because of the lack of asset visibility information. The CENTCOM J4 used the fielded capabilities of GCSS to get real-time location information on critical theater supplies that many assumed to be with the backlog of thousands of other items at Dover AFB, Delaware. He was not overly concerned with having the essential items in the theater because of the Total Asset Visibility and actionable decision information GCSS provided. GCSS ultimately enabled him to reduce the logistics footprint in the area of responsibility and avoid reordering critical items, which would have added to the congestion already in the logistics pipeline.[12] The asset visibility capability that GCSS gave the CENTCOM J4 is an integral part of the GCSS core capability, the ability to capture essential Total Asset Visibility logistics data and transform that data into usable information so DoD policy makers can make decisions that maximize the warfighter's readiness.[13]

The GCSS Concept

How, specifically, could GCSS build on the core capability described above to meet the OFT's requirements for network-centric logistics in the future? GCSS provides a centrally managed, open, Web-based information system in which the Services and DoD agencies operate and input logistics information into a GCSS family of systems (Figure 1, layer 3). The GCSS family of systems translates all raw data put in the network into usable GCSS information. The raw data from the Services and agencies include information from the transportation, supply, maintenance, personnel, acquisition, medical, finance, and engineering support domains (Figure 1, layer 4).

A Joint Asset Visibility and Joint Decision Support Tools server (Figure 1, layer 2) within the GCSS network then fuses and converts the information from the family of systems into real time, seamless, accurate, actionable, and common global asset visibility information for the user at the GCSS-combatant commander terminal (Figure 1, layer 1). With this construct, the GCSS-combatant commander or user at layer 1 has global access to logistics information—from each service component, defense agency, and the commercial sector—that spans across the strategic, operational, and tactical levels. Additionally, a classified suite of GCSS applications on the Secure Internet Protocol Network within layer 2 facilitates the fusion of logistics information with operational and intelligence information. The Joint Decision Support Tool (layer 2) translates this fused logistics, operational, and intelligence data into actionable information that enables joint decisionmakers to make timely and informed decisions to improve the readiness of the warfighter. Ultimately, authorized GCSS combatant commanders can access this shared data and its associated decisionmaking applications anywhere in the world.[14]

How GCSS Meets DoD's Network-Centric Logistics Requirement

With this basic understanding of the GCSS concept, one can now determine if GCSS capabilities meet the OFT's four critical requirements for the network-centric logistics system. The first critical OFT requirement for network-centric logistics is the provision of a common global asset visibility picture of all materiel within the DoD enterprise for authorized system users. GCSS meets this requirement by cutting across service component, unit, and DoD agency information stovepipes and reducing the overwhelming number of point-to-point connections that overload information flow to give authorized commanders and users real-time Total Asset Visibility. GCSS uses a single portal or server to serve as the second layer of the logistics management enterprise and integrate data from numerous family-of-systems logistics databases (Figure 1, layer 3) across DoD in a Web-based environment. Numerous legacy and disparate databases support and feed information into each of the individual family-of-systems databases.

For example, Air Force logistics databases, like the Information and Resources Support System, feed information into GCSS-Air Force (Figure 1, layer 3), and Army logistics databases, like the Standard Army Retail Supply System, feed information into GCSS-Army (Figure 1, layer 3). The majority of these support databases are controlled decentrally and managed by individual service components and department agencies, making it critical that all application developers ensure their systems comply with Defense Information Infrastructure and Common Operating Environment standards.

Article Highlights

DoD leadership must select a supply management system prudently so that joint warfighters are successful.

In today's uncertain and asymmetric strategic environment there is a requirement, perhaps even an imperative, in the DoD to find the best supply management system that keeps pace with the changing nature of warfare. DoD leadership must select a logistics management system prudently so joint warfighters are successful on the complex battlefields of today and tomorrow. In this article, Newkirk and Currie analyze and compare two major management system options.They use principles from DoD's network-centric warfare concept and lessons learned from Operation Iraqi Freedom as the basis for the analysis. Based on this analysis, they conclude that the DoD should adopt a modified version of the emerging but very powerful GCSS to best meet the logistics management needs of the joint warfighting commander.

Specifically, they conclude the uncertainties and asymmetric nature of today's strategic environment demand a management system that integrates logistics system capabilities and bridges service and agency stovepipes now. Future operations will be conducted in an increasingly joint manner and at a speed unprecedented in the past. The changing nature of warfare requires flexible and adaptive information systems. As a result, waiting 8 years for an unproven system squanders time, money, and possibly lives. Only GCSS-modified can provide combatant commanders and warfighters the capability needed to be successful on the battlefield now and in the future.

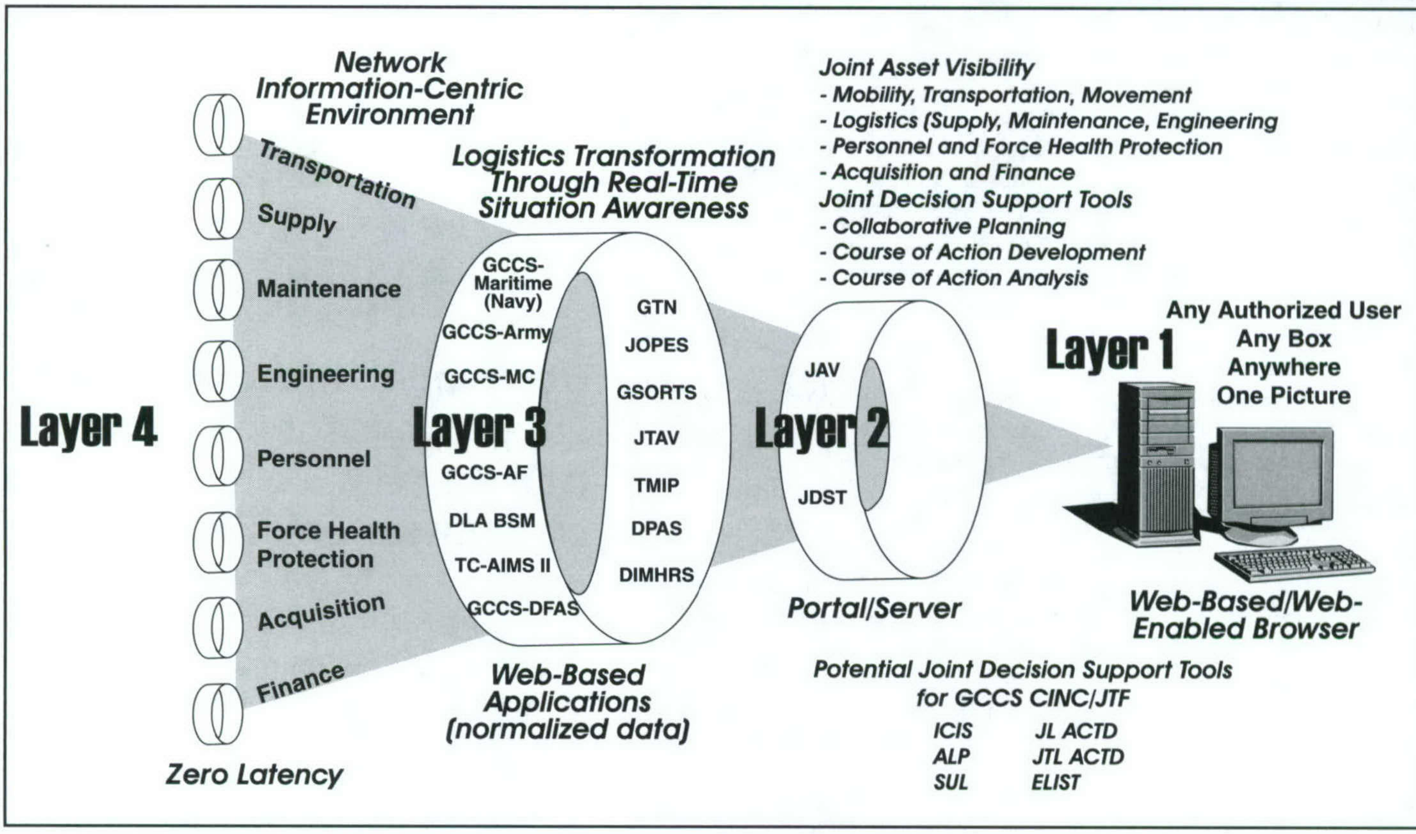


Figure 1. GCSS Concept[15]

To ensure that the Services and agencies are developing a GCSS family of systems that are interoperable and support the overall GCSS architecture, the JSJ4 has mandated that the Services and agencies use Defense Information Infrastructure and other baseline DoD "products, services, standards, and guidelines when migrating or developing software applications, or when upgrading or enhancing existing systems to plug and play into GCSS."[16] Additionally, each service or defense agency is responsible for ensuring that data within its family of systems is real-time and accurate. After all family-of-systems information is integrated and converted into common global asset visibility information in the GCSS server or portal (layer 2), it is sent to worldwide users with GCSS combatant commander terminals (layer 1). This GCSS construct fully meets the OFT asset visibility requirement by allowing any authorized user to access common asset visibility information anytime from any GCSS-combatant commander terminal.

The GCSS meets the second OFT requirement, recommending the most efficient and effective movement of supplies, with Joint Decision Support Tools (JDST). These tools form the cornerstone of the logistics management enterprise and rely on current and emerging systems like Agile Transportation for the 21st Century, Enhanced Logistics Intratheater Support Tool, and Joint Flow and Analysis System for Transportation.[17] They translate the raw data from numerous family-of-system databases into actionable information for battlefield commanders. The JDST projects equipment and unit readiness trends; identifies transportation, supply, and maintenance personnel shortfalls; and recommends how to alleviate those shortfalls.

Logistics data from JDST must be integrated continuously with warfighting operational and intelligence information for the joint commander to make informed supply management decisions. To facilitate this integration, JDST will tie into DoD's emerging global network-centric information infrastructure, the Global Information Grid (GIG). GIG ultimately will serve as the GCSS communications management backbone and act as a key enabler for the increased interoperability of GCSS with other DoD, government, and business entities.[18] Ultimately, JDST will give joint commanders the capability to make timely and informed decisions aimed at improving the readiness of warfighters whether they are in the foxhole, cockpit, ship, or base. With this capability, the JDST component of GCSS meets the OFT requirement to recommend the most effective and efficient move of materials to improve warfighting readiness.

The fourth OFT requirement, ready for immediate use and capable of quick modification, is exceeded easily by GCSS. GCSS JDST and almost all its family of systems are under initial development or undergoing their second and third iteration of modification. This evolutionary state of GCSS is not coincidental as the June 2000 Capstone Requirements Document for GCSS mandated the following developmental criteria.

- GCSS development must be versatile and evolutionary.
- It will follow evolutionary development and acquisition paths.
- The versatile and evolutionary development must be ensured through a modular software design that facilitates modification of the entire GCSS to include its family of systems.
- GCSS modules will be tailored without impacting other modules and the entire system.
- The flexibility of modular software and capabilities of GCSS will be adjusted readily to meet the needs of the warfighter.[19]
- GCSS will leverage commercial technology to optimize logistics processes in DoD while minimizing disruptions.[20]

Finally, the July 2003 *GCSS Enterprise Architecture Overview and Summary* emphasizes that GCSS, in spite of its name, is not a single system but a DoD logistics strategy that will continually build on existing technology, products, procedures, and integration processes in support of the warfighter. Each of the GCSS development standards aligns GCSS so that it meets OFT's requirements for a logistics system that is ready for use now and can be modified to leverage the capabilities of commercial and government technology.

Required GCSS Modifications

The third critical OFT requirement is establishing common logistics objectives and priorities that direct the movement of supplies within the DoD enterprise to meet warfighter requirements. The current GCSS architecture does not meet this requirement. However, three different system modifications would enable GCSS to meet OFT's logistics goals in this area, resulting in a GCSS-modified network.

The first part of the requirement is establishing common logistics objectives and priorities. Because the current GCSS architecture does not accommodate this critical function, GCSS developers must modify GCSS by incorporating a function that allows authorized commanders to integrate common supply priorities and objectives into the GCSS Joint Decision Support Tools. By allowing specified commanders in the GCSS network to enter supply objectives and priorities into the JDST, actionable information from GCSS not only is synchronized with battlefield operations but also is aligned with logistics parameters established by authorized commanders.

The second part of this OFT requirement, a system that triggers the immediate movement of supplies within the network, based on common objectives, requires the second modification to enable commanders to convert actionable JDST information into a GCSS tasking that directs supply and transportation owners to release and move needed supplies immediately after receiving a JDST recommendation. This *tasking tool* modification, combined with the *commander supply objective input* modification, would allow GCSS to meet the OFT system requirement partially that calls for the triggered movement of supplies and transportation assets in accordance with common or shared goals. However, to meet this OFT requirement necessitates a third GCSS modification.

With multiple commanders, from the strategic to the tactical level, using the joint tasking tool and establishing enterprise supply and transportation priorities within the DoD enterprise in an uncoordinated manner, network chaos and conflict are inevitable. For instance, when all four combatant commanders consider their theater a number one priority for the receipt of a scarce high-demand part or equipment item, decisionmakers above the theater level would need to serve as supply management arbitrators to allocate limited strategic transportation and supply resources to a combatant commander's theater based on national priorities. Permanent logistics command and control (C2) nodes would have to be established within the GCSS network from the strategic to the tactical level to deconflict and modify supply and transportation priorities and then adjust unit force activity designators as required.[21] So where should these C2 nodes be located in the GCSS enterprise?

The current GCSS architecture was designed so that almost all actionable information within GCSS is provided to combatant commanders and their staffs on the GCSS-combatant commander terminal (Figure 1, layer). The combatant commanders need much of this actionable information to make many theater-wide operational material distribution management decisions. Although combatant commanders have access to strategic-level logistics information using GCSS, they do not have the time or resources to manage strategic assets outside their theaters. Lieutenant General Zettler, former Air Force Deputy Chief of Staff for Installations and Logistics, confirmed the challenges associated with supporting combatant commanders when there is not a dedicated single entity in the DoD that focuses on managing and prioritizing strategic-level logistics.

> We had combat forces deployed in support of Operations Northern and Southern Watch…we were building up forces in support of Operation Enduring Freedom. At the same time, many continental US-based forces were flying in support of Operation Noble Eagle. Concurrently, we continue our day-to-day vigilance over the skies of South Korea. Arguably, any of these missions could be seen as top priority. However, when everything is priority one, nothing is priority one. Compounding the problem of the number of missions was the fact they crossed all major commands.[22]

To alleviate these logistics prioritization and management challenges, the Secretary of Defense designated the US Transportation Command (TRANSCOM) as the DoD distribution process owner in September 2003. TRANSCOM realizes that the current DoD supply distribution system is a complex conglomerate of optimized stovepipes and bottlenecks, with no one accountable, and understands that its ownership of the distribution process gives it the ability to manage and control supplies and transportation assets across all the Services and agencies in DoD from the factory to the foxhole. Its ultimate goal is to make the current supply distribution process more effective and efficient to optimize support to theater commanders, in accordance with national objectives.[23] Given TRANSCOM's new logistics responsibility within DoD, it makes perfect sense for TRANSCOM to serve as a major logistics C2 node in the GCSS network.

As a major C2 node, all global and strategic supply and transportation management issues would become the TRANSCOM Commander's responsibility. The TRANSCOM Commander would use strategic asset visibility information in GCSS-modified to establish worldwide supply priorities and then direct DoD agencies, using the GCSS tasking tool, to redistribute those supplies. As the owner of the strategic-level C2 node, TRANSCOM could designate other GCSS C2 nodes at the strategic level. These designated strategic-level C2 nodes would establish supply priorities that align with TRANSCOM's overarching supply objectives. Additionally, GCSS C2 nodes designated by TRANSCOM would use the tasking tools on their GCSS-modified strategic terminal to task DoD agencies to reallocate supply and transportation assets within the network. The other major logistics C2 node within the GCSS network should be at the combatant commander's level. Combatant commanders should establish their own supply priorities, but their priorities should align with TRANSCOM's priorities. Similar to TRANSCOM, combatant commanders could allow designated C2 nodes within their theater to establish more specific supply objectives and use tasking tools on their GCSS-modified-combatant commander terminal to reallocate logistics resources within the theater.

Establishment of strategic- and theater-level C2 nodes is an absolutely critical modification to the GCSS architecture because it ensures the thousands of DoD materiel management transactions within the GCSS logistics network are fully integrated and synchronized. This final modification, combined with the two mentioned earlier, enable GCSS to meet the third critical OFT network-centric logistics requirement that calls for establishment of mechanisms that direct the movement of materiel within the network based on common network objectives. Ultimately, these GCSS modifications enable GCSS to meet all four of OFT's critical network-centric logistics requirements. Additionally, this modified version of GCSS would have solved many of the Iraqi Freedom supply management challenges.

Use of GCSS-Modified to Solve Iraqi Freedom Supply Challenges

With the extensive use of systems that relied on information technology during the war in Iraq, many historians may portray Iraqi Freedom as the first information age war.[24] During Iraqi Freedom, joint staffs, using early baseline models of GCSS, had unprecedented asset visibility of critical equipment and supplies in the distribution pipeline between the continental United States and the Iraqi area of operations.[25] In spite of this excellent asset visibility of material flowing into the area of operations, a lack of asset visibility in the theater, intratheater transportation shortfalls, and a consistent inability to predict the daily requirements of the warfighter resulted in widespread shortages of certain supplies and large surpluses of other items in forward units. Additionally, because there was no single system that provided strategic leaders in DoD with asset visibility of common service items, joint staffs took days and sometimes weeks determining how best to redistribute critically short items between the Services and theaters.[26]

What were the supply management and distribution problems during Iraqi Freedom that could have been corrected with GCSS-modified? First, there was no joint supply database that had global asset visibility of all warfighting supplies and equipment in supply depots above the combatant commander level. Additionally, after taking several days to determine the worldwide status of selected supplies, strategic-level logistics commands took a few more days to coordinate the release and movement of the supplies needed to support the combatant commander in the Iraqi area of operations.[27] The TRANSCOM Commander's observations regarding supply distribution at the strategic level during Iraqi Freedom confirm these shortfalls.

> There are too many seams in the supply chain today. If you try to do a chart of all the things that happen, you find a cobweb of networks, each with different technology and cultures. Ultimately, not only TRANSCOM and DLA but also the military services' logistics organizations should be brought under a single command to ensure that warfighters get the same level of service.[28]

Similar supply management challenges occurred during the deployment phase of Iraqi Freedom when the Army had problems ensuring its soldiers deployed with the prescribed number of desert camouflage battle dress uniforms (DCU) and joint service lightweight integrated suit technology (JSLIST). Because of the lack of asset visibility of these common service items, not only within the Army but also across the DoD enterprise, it took weeks for the Army and joint boards on the Joint Chiefs of Staff to make redistribution decisions that would ensure soldiers deployed with the proper number of desert camouflage uniforms.[29]

GCSS-modified would have fixed these Iraqi Freedom logistics problems by giving the TRANSCOM Commander, as the designated GCSS strategic C2 node owner, worldwide visibility of DCUs and JSLIST within the DoD enterprise. The GCSS-modified JDST then would have allowed the TRANSCOM Commander to task units instantaneously to release and transport DCUs and JSLIST to the deployable units that were short these items. This redistribution process, which took weeks during Iraqi Freedom, would have taken hours using GCSS-modified.

The next Iraqi Freedom challenge that could have been corrected with GCSS-modified was the lack of asset visibility of supplies within the theater and recurring shortages and surpluses of supplies within tactical units. OFT and other military officials identified a consistent lack of asset visibility knowledge once supplies and equipment were removed from containers at the ports of debarkation and pushed into distribution pipelines within the theater. Adding to this problem was the lack of reliable communications within combat service support units, which prevented tactical units from transmitting their current and future supply requirements to theater-level supply bases.[30] Because of the theater staff's lack of information regarding daily supply requirements and on-hand quantities in tactical units, theater-level logisticians pushed supplies forward based on their *best guess* of warfighting unit needs. This *best guess* technique for distributing supplies in the theater resulted in supply shortages for some items and unnecessary supply stockpiles of other items at the tactical level.[31]

Additionally, during the Iraqi Freedom ground war, BA-5590 batteries, high-demand batteries used in numerous Marine and Army electronic devices, were projected to become critically short within the Iraqi theater. Tactical Marine and Army units were required to negotiate the local redistribution of these batteries to meet current and short-term requirements. The joint force logistics staff was required to establish a joint common use distribution center to determine authorized stock levels for batteries and direct additional redistribution among service components to meet projected supply demands based on future operational requirements.[32] GCSS-modified would have met these shortfalls by giving the theater J4 asset visibility of all supplies in the theater distribution pipeline and providing redistribution recommendations to task-specific units to release batteries to meet warfighting unit requirements. Ultimately, GCSS-modified would have been far more effective than the *best guess* technique used for distributing supplies during Iraqi Freedom. Moreover, the need for units, Services, and the joint staff to spend hours coordinating to determine BA-5590 battery and other common item distribution and stock-level requirements would have been eliminated with GCSS JDST.

Finally, the lack of robust communications assets to facilitate passing logistics information greatly hindered logistics distribution and management during Iraqi Freedom. The current GCSS architecture fixes this problem by tying into and taking advantage of services in the emerging GIG enterprise. A fully operational GIG would have provided the needed communication management infrastructure that GCSS requires for continuous collaboration among network units. Given GCSS-modified logistics capabilities, one must ask, is GCSS-modified the system that the OFT should adopt to meet DoD's network-centric logistics requirements, or is there another logistics system in the commercial sector that would do a better job of meeting the requirements?

GCSS-Modified Versus S&RL Commercial Logistics System

To find a baseline logistics management system that best meets DoD's network-centric logistics requirements, the OFT is looking aggressively at the best commercial logistics management systems. It has discovered that numerous large commercial entities are using an S&RL management concept to meet supply management requirements in the network-centric domain. Major commercial entities in the United States, such as the automobile and electronics industries, are using the S&RL concept that originated with IBM.[33] S&RL developers in the OFT are striving to ensure that the S&RL material solution meets all network-centric logistics requirements addressed earlier.

The projected S&RL meets all OFT requirements except one of the developmental requirements (Table 1). Unfortunately, the projected S&RL's inability to meet the requirements of this one criterion causes the current S&RL to not meet any of OFT's network-centric logistics criteria. Because of the significant impact this one criterion has on the overall differences between the GCSS and S&RL options, this section focuses on GCSS' and S&RL's ability to meet OFT's fundamental developmental requirements. Using these fundamental developmental requirements as the criteria for comparing GCSS and S&RL, one is able to determine the superiority of one system over the other.

S&RL's Capability

In its efforts to find a system that meets these foundational developmental requirements, the S&RL team assumes that the best information age logistics management models are in the commercial arena; however, it acknowledges that a single company or technology will not be able to provide the end-to-end solution that DoD needs to meet its network-centric requirements in the logistics domain. Therefore, the S&RL team is adopting a *best of the breed* approach that integrates the best current or future products of a company into the DoD logistics system. By keeping everything modular, components can be added, deleted, or swapped for better or different ones as requirements and technology evolve. To influence current logistics operations, the S&RL team within the OFT is investigating commercial logistics system prototypes. The Marine Corps is scheduled to test the S&RL concept in Sea Viking 04. Additionally, S&RL concepts tests are conducted in Unified Course 04 and Global Engagement VI. As S&RL concept tests conducted during these exercises, Synergy Corporation will continue to engage in its 24-month effort to develop a prototype system.[34] Once this prototype is found, it will be developed with emerging and leading technologies derived from the commercial organizations that produce and use information technology to gain a competitive advantage. The S&RL development team is looking for a logistics system that is flexible enough to be tailored quickly and linked easily to emerging DoD network-centric architectures.[35] The ongoing efforts show that the projected S&RL meets fundamental network-centric logistics developmental requirements one and two; however, these efforts do not come close to meeting the third requirement to be available for immediate use in the DoD.

GCSS Capability

An examination of GCSS developmental efforts leads one to discover that in 1996 GCSS developers also assumed that the best logistics management tools were in the commercial sector. By keeping everything modular, developers easily could integrate the best commercial products into the basic GCSS logistics system. Unlike the S&RL option, GCSS developers already have fielded a basic logistics system in DoD and have been integrating the best commercial and government modular products into the system for the last 3 to 4 years. GCSS has found and fielded numerous prototypes that have been developed rapidly with emerging and leading technologies derived from commercial organizations. These prototypes have been developed using a multitude of Web-based applications and leading technologies associated with the family of systems and the joint decision support tools. Additionally, efforts are ongoing to tie the current version of GCSS into the DoD's GIG to give GCSS the base it needs to support users anywhere in the world.

Whereas the current GCSS meets all the fundamental developmental requirements, the current S&RL meets none of the developmental requirements. The projected GCSS and projected GCSS-modified meet all three developmental criterion, while the projected S&RL meets only two of the three requirements (Table 1).

Even if S&RL developers found a baseline logistics management system comparable to or better than GCSS today, it would take approximately 8 years before that system achieved an initial operating capability within DoD. This 8-year period is the average time it takes a major defense system to move from the *research initiation* phase of the acquisition cycle to the initial operating capacity in the field phase of the cycle.[36] Therefore, the initial fielding of material components for S&RL would not occur until 2012. Thus, the capability rating for the current S&RL in Table 1 would not increase to a number above zero until 2012. Unlike the current S&RL, the current GCSS capability rating in Table 1 would increase to a number greater than ten by 2007 because the current GCSS architecture is projected to be fully operational in 2006.[37]

Clearly, developmental efforts and objectives that S&RL and GCSS developers are using to meet DoD's network-centric requirements are the same, resulting in redundant and inefficient work in DoD. Table 1 shows the redundancy in the projected capabilities of GCSS and S&RL. In spite of efforts to provide the joint warfighter with the same network-centric supply management capabilities and the significant time lag in the acquisition and development of the S&RL option, compared to the GCSS option, the OFT continues to pursue the S&RL option. As S&RL developers conduct additional concept development and research to find the perfect network-centric logistics prototype, time and resources are being wasted.

Consequently, because GCSS developers already have found a suitable network-centric logistics system, the OFT's S&RL development team should terminate its efforts. The OFT, S&RL, and GCSS teams should consolidate efforts so that logisticians in DoD are working toward the common executive goal of modifying and improving the GCSS network-centric logistics system that has proved itself and has tremendous potential for meeting warfighter logistics requirements in the future. This recommendation is in line with Secretary of Defense Donald Rumsfeld's recent testimony implying a need to shift to the GCSS option.

NWC Logistics System / Requirements	Current S&RL	Current GCSS	Projected S&RL	Projected GCSS	Projected GCSS-Modified
A single logistics terminal provides a common Global Asset Visibility picture of all supplies in all services/agencies and in the distribution pipeline.		X	XX	XX	XX
System automatically recommends that supplies be redistributed between supply depots and units based on common supply objectives established by designated network commanders and battlefield conditions.		X	XX	XX	XX
System immediately directs suppliers and transportation units to release and move supplies respectively based on trigger mechanism above.			XX		XX
Fundamental Developmental Requirements					
System continuously leveraging best commercial and government technologies.		XX	XX	XX	XX
System readily modified to integrate the latest technology and achieve interoperability with the emerging DoD information network architecture.		XX	XX	XX	XX
Basic system (current or projected) ready for immediate use in DoD.		XX		XX	XX
Overall Capability Rating (Total Xs)	0	8	10	10	12
XX: System fully meets requirement. X: System partially meets requirement. Higher overall capability rating is better.					

Table 1. Developmental Requirements

> A different approach is to start with the basics, simpler items, and roll out early models faster—and then add capability to the basic system as they become available. This is what the private sector does—companies bring a new aircraft online for example and then update it over a period of years with new designs and technologies. We need to do the same.[38]

GCSS could be categorized as the basic, simpler item. GCSS is truly an early model of the S&RL prototype that can be *rolled out into DoD* to meet a large percentage of the OFT's network-centric requirements. The modular, adaptive framework of GCSS makes it a prime candidate for updating over a period of years with new designs and technologies. As Rumsfeld stated, "We need to do the same" as the private sector with GCSS. His guidance suggests that DoD logisticians should redirect their energy toward refining the current GCSS. The current version of GCSS that has been fielded across DoD meets approximately 20 percent of the OFT network-centric logistics requirements, whereas the current S&RL meets zero percent of the requirement (Table 1). Additionally, GCSS-modified has a much greater potential for meeting all DoD's network-centric logistics requirements sooner than the projected S&RL system.

Given the Secretary of Defense's guidance regarding the acquisition of major systems in DoD and the analysis and comparison of the S&RL and GCSS options above, the GCSS-modified network-centric logistics system is clearly the best system for the DoD enterprise and the joint warfighter. Therefore, all DoD efforts to provide the warfighter with the best network-centric logistics system should be focused on improving GCSS (the GCSS-modified option) versus finding a better commercial logistics system (the S&RL option). Acquiring a network-centric logistics system that can effectively and efficiently support US forces' network-centric operations could turn out to be the linchpin for the complete transformation of network-centric warfighting forces, which may be needed sooner rather than later.

Conclusion

Finding the supply management tools that will allow the US military to meet the requirements for effective and efficient military supply management is one of DoD's toughest challenges. During Operation Desert Storm in 1991, inefficient and ineffective logistics management caused the buildup of more than 40,000 containers of supplies in intheater seaports. More than half these containers were frustrated at ports because of time-consuming inventories to find out what was in them. To overcome these distribution inefficiencies, warfighting units frequently found substitute items or reordered the supplies, compounding the congested supply pipeline problem.[39]

The baseline GCSS hardware fielded to geographic combatant commanders during 2002 and 2003 fixed many of the asset visibility problems encountered during Operation Iraqi Freedom. Consequently, during Iraqi Freedom, the CENTCOM Commander and the staff had significantly more knowledge regarding the location of critical supplies and equipment moving from the continental United States to the Iraqi theater of operations, giving the theater CENTCOM Logistics Director increased confidence in the supply distribution system. Additionally, this improved asset visibility reduced over-ordering and the *iron mountains* of supplies at ports of debarkation that were prevalent during Desert Storm.[40] However, based on future network-centric warfighting requirements and Iraqi Freedom logistics lessons learned, there are additional critical capabilities that must be incorporated in the defense supply management system to maximize support to the joint warfighter. OFT has developed a thorough list of required capabilities for the new supply management system. Therefore, the current dilemma within the DoD concerns selecting the best system that fully integrates the requirements.

The uncertainties and asymmetric nature of today's strategic environment demand a supply management system that integrates the OFT supply system capabilities and bridges service and agency stovepipes now. Further, Iraqi Freedom demonstrates that future operations will be conducted in an increasingly joint manner and at a speed unprecedented in the past. Keeping pace with the changing nature of warfare requires flexible and adaptive information systems. Waiting 8 years for an unproven sense and respond logistics system squanders time, money, and possibly lives. GCSS-modified is truly the system that can provide combatant commanders and warfighters with the logistics management capability needed for success on the battlefield, now and in the future.

Notes

1. This definition for logistics supply support is very similar to the Joint Staff J4's definition for Focused Logistics. For more information see "Focused Logistics Campaign Plan," Joint Staff/J4, no date, 4 [Online] Available: http:dtic.mil/jcs/j4/projects/foclog/focusedlogistics.pdf, Nov 03.
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6. "Joint Operations Concepts," Nov 03, 14.
7. "Sense and Respond Logistics: Co-Evolution of an Adaptive Capability, Concept of Operations," iv.
8. "Sense and Respond Logistics Capability and Operation Iraqi Freedom," Science Application International Corporation, 5 [Online] Available: http://www.oft.osd.mil/initiatives/srl/srl.cfm, Nov 03.
9. "Sense and Respond Logistics Capability and Operation Iraqi Freedom," 15.
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27. This information is based on personal observations while working in the Logistics Cell in the Army Operations Center at the Pentagon from Feb to Jun 03.
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29. This information is based on personal observations while working in the Logistics Cell in the Army Operations Center at the Pentagon from Feb to Jun 03.
30. "Sense and Respond Logistics Capability and Operation Iraqi Freedom," 21.
31. "Sense and Respond Logistics Capability and Operation Iraqi Freedom," 16.
32. *Ibid.*
33. "Sense and Respond Logistics: Co-Evolution of An Adaptive Capability, Concept of Operations," 3.
34. S&RL Concept Testing and Prototype Development information was obtained from "Adaptive Enterprise Transformation: Sense and Respond" conference notes, Col Karen Currie, Faculty, Air War College, Maxwell AFB, Alabama, 2-3 Dec 03.
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37. Erb, 9.
38. Erb 80.
39. Hodierne, 16.
40. *Ibid.*

Colonel Newkirk is a faculty member in the Joint Military Operations Department, Naval War College, Newport, Rhode, Island. At the time of the writing of this article, he was a student at the Air War College. Colonel Currie is on the faculty at the Air War College, Maxwell AFB, Alabama.

notable quotes

Transformation is not a term; it is a philosophy—a predisposition to exploring adaptations of existing and new systems, doctrine, and organizations. It has been part of the Air Force for decades. Transformation is not outlining new programs or things to buy. Rather, it is an approach to developing capabilities and exploring new concepts of operation that allow us to be truly relevant in the era in which we find ourselves, and for years to come.

—Dr James Roche, Secretary of the Air Force

Introduction

Special Feature

The Department of Defense (DoD) has become increasingly reliant on contractors to accomplish the mission. Declining budgets and the reduction in force structure stemming from the peace dividend from the end of the Cold War forced the DoD to seek less expensive and more efficient ways of doing business. More and more, contractors are being called on to perform tasks historically performed by military personnel.

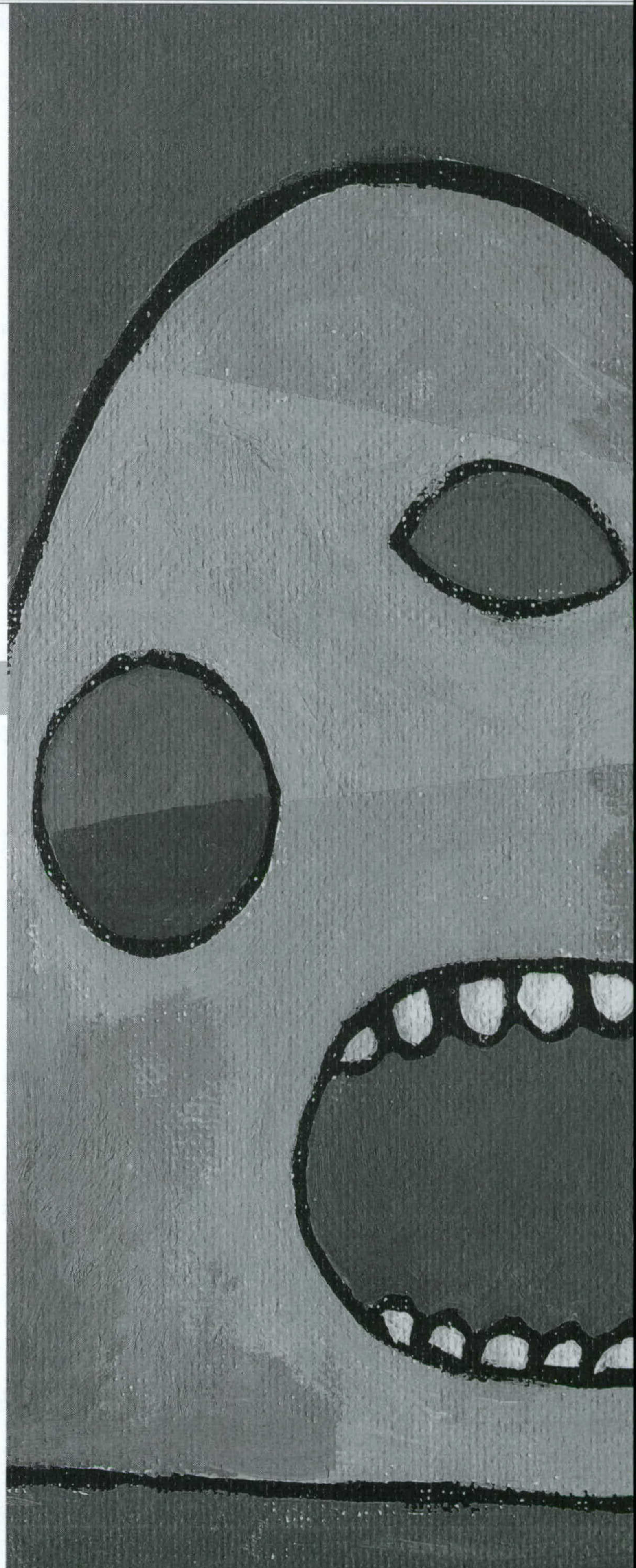
A myriad of factors addressed in the forthcoming pages drive continued reliance on contractors. One reason, often touted, is that contracting out operations saves money. On the surface, this seems to be true, but is the United States really saving money? Is the military required to *prove it*?

Background

Using contractors in military operations is not a new phenomenon. In fact, contractor use by the United States began prior to the Revolutionary War. During the Revolutionary War, the United States used contractors to move supplies to the front line.[1] Since then, contractors have filled important support roles in every conflict with US involvement, including Operation Iraqi Freedom. Table 1 shows civilian and contractor support levels in US conflicts, up to and including operations in Bosnia. Although figures are not yet available, the number of contractor persons providing support during Iraqi Freedom is sure to be a staggeringly large number. During the first Gulf War and again in Iraqi Freedom, the United States relied extensively on host-nation support contracts. The military, either directly or through host-nation support contracts, contracted for such items as cooks, water delivery, construction labor, and truck drivers. During Iraqi Freedom, third country national contractor persons numbered in the thousands in Kuwait alone.[2]

As the reliance on contractors has grown, the types of tasks contractors are being called on to perform are increasing as well. Contractors are finding their way into every facet of operations. Where the United States once relied on contractors solely for logistical support, contractor personnel now maintain and operate systems supporting the combatant commander. In some cases, contractors are being called on because they provide an expertise not organically possessed within the military. In other cases, they are being called on because they provide services faster, less expensive, and with less overhead than the military. Regardless of the reason, as contractors become more and more integrated into operations, the lines between combatant and noncombatant status are being blurred.

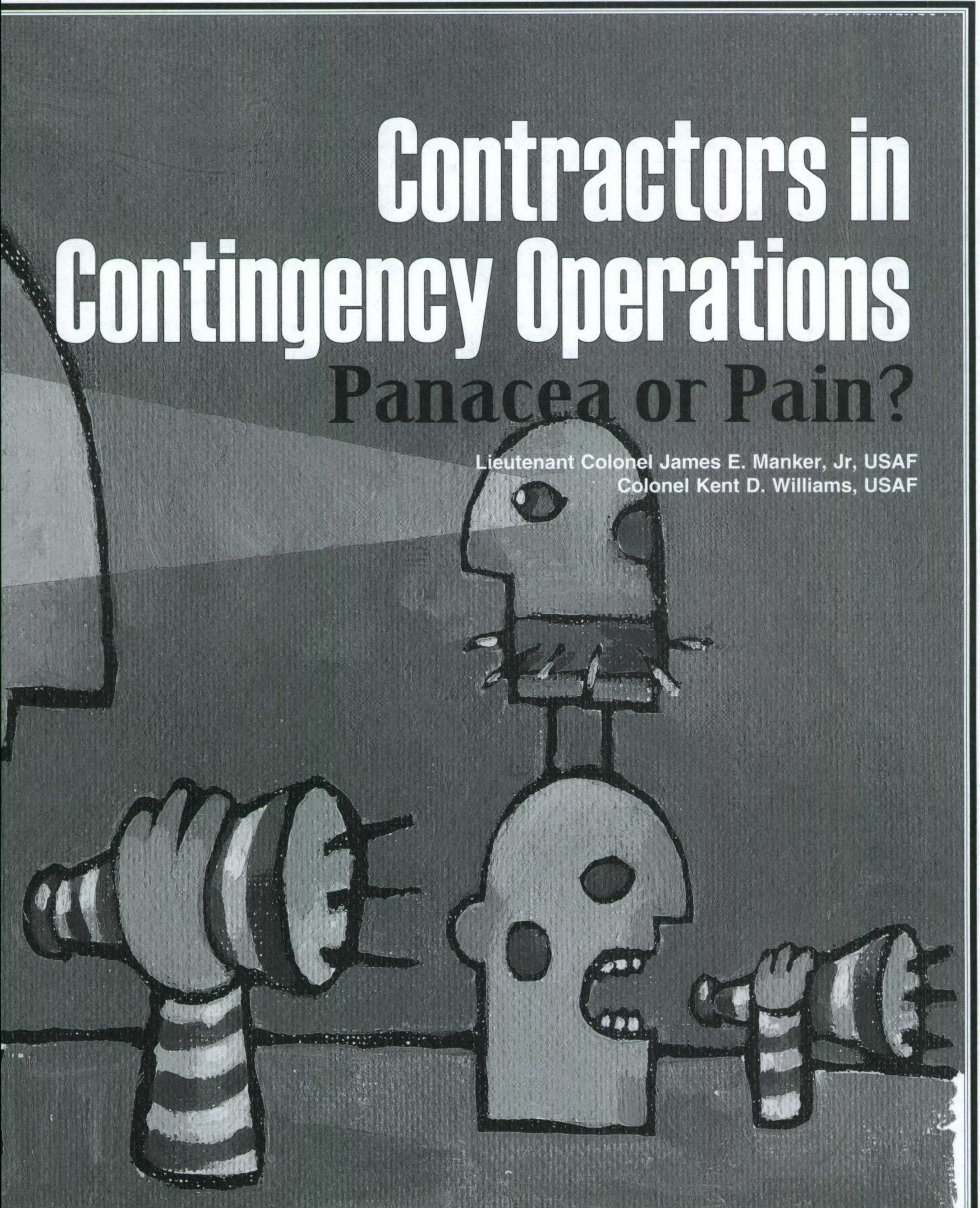
As the role of the contractor has expanded, the contractor's proximity to the battlefront has decreased. In the modern warfare era, there no longer is a distinctive line between battling forces. As a result, the contractors may find themselves close to the



Contractors in Contingency Operations

Panacea or Pain?

Lieutenant Colonel James E. Manker, Jr, USAF
Colonel Kent D. Williams, USAF



War/Conflict	Civilians	Military	Ratio
Revolution	1,500 (est)	9,000	1:6 (est)
Mexican/ American	6,000 (est)	33,000	1:6 (est)
Civil War	200,000 (est)	1,000,000	1:5 (est)
World War I	85,000	2,000,000	1:2
World War II	734,000	5,400,000	1:7
Korean Conflict	153,000	393,000	1:2.5
Vietnam Conflict	70,000	359,000	1:6
Desert Storm	9,000	400,000+	1:5
Bosnia	300	3,000	1:10

Table 1. Contractors and Civilians on the Battlefield[3]

forward edge of the battlefield conducting activities, whether intentional or unintentionally.

Contractors who are supporting military operations are deployed globally, including the Central Command Area of Responsibility, providing support across Iraq. Contractors face the same dangers that military personnel encounter in the Middle East. During the conflict, they faced the potential for Scud attacks. Since our move into Iraq, contractors have suffered firsthand from attacks.

Even when the contractor is not fully deployed to the forward edge of the battlefield, the Global War on Terrorism poses a new threat to the theater of operation. Force protection issues have taken on increased importance with the deployed commanders. Their worries are not limited to the enemy's fielded forces and their inherent threats; now contemporary warfare and the threat of insurgencies bringing the battle to the rear area is a reality. Rear locations, once considered safe havens for troops to rest and relax, are potentially as dangerous as the front lines. This danger is not limited to troops: Americans and those who support American efforts are now targets. In many cases, the contractor poses a *softer* target to terrorists and is targeted specifically for that reason. News reports from Iraq indicate terrorists are actually targeting contractors and nongovernmental organization personnel because they are easy marks. During the last year, contractors were captured and killed supporting US military operations in Central America and the Middle East.

Contractors present multiple challenges to combatant commanders. Their status while deployed supporting contingency operations presents a real problem. The nature of the tasks contractors perform often blur the line between combatant and noncombatant status. Additionally, only a few status of forces agreements exist between the United States and countries around the globe that specify the status contractors will enjoy while deployed with forces. For those countries in which contractors are not covered by a status of forces agreement, the question arises as to the military's responsibility to ensure contractors understand the law and, more important, follow the law. Further, combatant commanders bear responsibility to account for contractors deployed to their areas of responsibility—unfortunately, responsibility does not constitute adherence.

Contractors also present challenges and concerns to forward-deployed commanders. Depending on the contract agreement, the deployed commander may have responsibility for providing force protection. If not specifically stated, do contractors have a right to the same level of protection? If so, who is responsible for providing the support? Depending on the service, the answer varies. Can a commander compel contract employees to perform if they refuse?

A myriad of factors addressed in the forthcoming pages drive continued reliance on contractors. One reason often touted is that contracting out operations saves money. On the surface this seems to be true, but is the United States really saving money? Is the military required to *prove it*?

Why Is the Military Increasingly Reliant on Contracts?

Although not a new phenomenon, contractors are prevalent in all phases of military operations. In the wake of 11 September 2001, the Air Force requested an end-strength increase of 7,000 persons.[4] Secretary of Defense Donald Rumsfeld rejected these plans stating the Air Force should contract out those jobs that could be outsourced and use the savings to satisfy newly identified requirements.[5] The need for additional manpower supporting the Global War on Terrorism, coupled with tight defense budgets, is moving outsourcing and privatization from the *virtue* to the *necessity* category.[6] Everywhere the United States deploys forces, there is likely to be a contractor assisting in one form or another. As discussed, the military has not gone to war without contractors providing support. Blurring the line between military and civilian, they provide everything from logistical support to battlefield training, as well as advise the military at home and abroad.[7] In some cases, contractors perform traditional military roles in parts of the world the military no longer has the strength to perform the duties.[8] One of the main reasons for using a contractor is saving the United States from using troops in positions not requiring warfighting skills so those troops can focus on positions requiring warfighting skills.[9] Additionally, in the Air Force's case, the air expeditionary force (AEF) construct provides air force personnel with deployment lengths of 90 days. Contractors represent a steady workforce to provide continuity at deployed locations. Certainly, a multitude of reasons exists for using contractors versus possessing an organic capability. The following discussion focuses on four dramatic reductions in uniformed personnel strengths in the DoD: the need to refine the tooth-to-tail ratio, thereby improving the cost effectiveness of the DoD; increasing complexity of fielded systems; and internally or externally mandated limitations on troop strengths participating in contingencies.[10]

Troop strengths since the late 1980s have decreased dramatically, while the operations tempo has increased. As part

The growing complexity of these advanced weapon systems has led to further reliance on contractor support closer and closer to the battlefront.

of the peace dividend from the end of the Cold War, the DoD reduced its uniformed force by more than 700,000 active-duty military persons and its civilian workforce by more than 300,000.[11] Despite the fact that the Cold War ended, the operations tempo and likelihood of military deployments for the military actually increased. Since the end of the Cold War, the military has deployed with a frequency nearly five times higher than before.[12] The Guard and Reserve are not immune to this trend—their strength decreased more than 1 million, while the number of man-days served per year continues to increase.[13] The mission continues to grow while personnel available to accomplish the mission steadily decreased. Increased reliance on outsourcing proves to be one of the few reasonable alternatives.

Reduction in personnel forced the DoD to recognize the need to refine its tooth-to-tail ratio. During the mid-1990s, Vice President Al Gore's *reinventing government* initiative placed further emphasis on outsourcing and privatization.[14] A report by Business Executives for National Security stated there is an acute need for DoD to fix the way it manages its service and support infrastructure. While the military continues to reduce and reorganize its fighting forces, spending on support functions has remained stable or even grown. Nearly 70 percent, roughly $160B annually, of the defense budget is going to areas considered the *tail* or support portion of the military.[15] With such a large percentage going to support, that leaves limited dollars for the primary purpose of the DoD, fighting and winning wars—the *tooth*. Many of the functions accomplished by uniformed personnel could be accomplished easily by contractor personnel with little to no degradation in service. The 2001 Quadrennial Defense Review stated that the contractor-to-soldier ratio will continue to rise, and contracting out battlefield services will become a standard operating procedure for the military.[16] With the number of contingencies the military finds itself involved in with a limited number of troops to draw from, the logical outcome is contracting out heretofore inherently military functions. During a recent interview Rumsfeld was asked whether contractors hired under the Army's Force XXI concept would be on the battlefield. He responded that combatant commanders decide employment of assets; however, because of the type of work, some contractors likely will be on or near the battlefield.[17]

The ability to downsize has been, at least partially, mitigated by the growing lethality of weapon systems. From an air perspective, a mission that might have taken multiple sorties to accomplish before can be achieved with a single sortie using precision-guided munitions launched from technologically advanced and complex platforms. In fact, using the B2 bomber during Iraqi Freedom, the Air Force was able to attack multiple targets with a single sortie. These advancements are not limited to the Air Force; all the Services are experiencing such technological advances. These advancements reduce the number of military in theater but may increase the number of contractors.

The growing complexity of these advanced weapon systems has led to further reliance on contractor support closer and closer to the battlefront. In many cases, we do not have enough of these low-density, high-demand platforms to develop an organic repair capability. In other cases, increasingly sophisticated military software and hardware have fueled outsourcing. Development of an organic repair capability would take years; by which time, the software and hardware and, therefore, the repair capability would be obsolete.[18] Further, some systems, such as a new truck being

Article Highlights

Issues regarding host-nation support contracts must be clarified.

Declining budgets and the reduction in force structure stemming from the peace dividend accrued at the end of the Cold War have forced the Department of Defense to seek less expensive and more efficient processes and ways of doing business. As a result, contractors are being used to perform tasks that historically have been the purview of military personnel—tasks that often put them much closer to or on the battlefield.

In this article, Manker and Williams examine the implications and issues associated with the increasing role of contractors. In the course of the article, they outline the key issues—when contactors refuse to perform, dangers posed to and by contractors, and host-nation contracts. They conclude that contractor status while serving in forward-deployed locations needs to be clarified and addressed, service doctrine needs to change and address several major issues or problems—force protection of contractor personnel and commander authority over contractor personnel—critical missions that have been contracted out must be identified and an organic capability developed, the Services must develop a consistent methodology to measure whether combatant commanders are actually saving money by using contract support, issues regarding host-nation support contracts must be clarified, and combatant commanders need tools to keep track of contractor personnel in their area of responsibility.

fielded by the Marine Corps, were designed and implemented with contractor support planned as the principal means of repair.[19] The military is making a conscious decision to allow contractors to perform all services associated with a system, from cradle to grave.

In addition to repairing equipment, contractors increasingly are being called on to operate systems.[20] During the first Gulf War, contractors flew side by side Air Force personnel on joint surveillance aircraft and target attack radar system aircraft, providing much needed technical support on the newly fielded platforms.[21] All these trends leading to increased reliance on contractors also lead to the potential of placing contractors in harm's way.

Finally, the necessity to use contractors often is driven by the need to keep force strength below mandated levels. These force strength restrictions can originate from Congress, the President, or the host nation. During Vietnam, Desert Storm, and Kosovo, contractors allowed the military to deploy more firepower while staying below congressionally mandated limits.[22] In essence, you keep the numbers down while contractors make up the difference.[23] The host nation can and has placed limitations, by way of a status of forces agreement, on the number of military forces deployed to a contingency.[24] The use of indigenous support contractors reduces the need to deploy support functions while the indigenous support does not count against the total number of forces deployed to a region. This allows for deployment of larger numbers of fighting *tooth* forces without increasing the need to deploy support *tail* forces. An added incentive to hiring indigenous contract personnel is that local manpower often is considerably cheaper than military support or US-provided manpower. In addition, hiring local contract personnel provides economic stimulus to the local host-nation economy.

Types of Contracts

According to Joint Publication 4-0, there are three broad categories in which contractors provide support: systems support, external theater support, and theater support.[25] In most cases, these contracts are let on behalf of the DoD to benefit using new or existing contracts. However, during Operation Southern Watch and the buildup to Operation Iraqi Freedom, the DoD relied heavily on contracts let by the Government of Kuwait on behalf of the DoD.

System Support Contracts

System support contracts are fairly straightforward. These types of contracts provide life-cycle support for weapon and other systems fielded by the DoD. The types of systems being maintained include vehicles, aircraft, computer systems, and a command and control infrastructure. This support can be provided at the home base or can be for maintenance and support of equipment deployed forward.[26] Historically, weapon system developers would build a system, deliver it to the military, and then walk away. Now, the contractor is just as likely to build the weapon system and then remain with it to provide follow-on maintenance. One author attributed the growth of contractor-provided maintenance to a growing reliance on civilian technology adapted for military use. Complexity, combined with finite production runs, has made it uneconomical for the military to develop an organic repair capability.[27] Whatever the case, the DoD is seeing a large increase in system support contracts.

External Support Contracts

External theater support contracts normally are contracts established and managed at the service level to provide support at deployed locations prior to the troops actually deploying. Services contracted via external support contracts include such items as roadbuilding, building airfields, channel dredging, stevedoring, transportation services, billeting, and food services.[28] These contracts provide support before, during, and after the deployment. They are an excellent means of allowing our overburdened soldiers, sailors, and airmen to return home after the contingency is won but before the need for follow-on support is complete. The Army, Air Force, and Navy each have indefinite-delivery, indefinite-quantity (IDIQ) contracts for support services and can call on the contracts as needs arise.[29]

The Army's IDIQ contract is the Logistics Civil Augmentation Program (LOGCAP) with Kellogg Brown and Root (KBR).[30] Recent work completed by KBR on LOGCAP was the establishment of an entire base camp in both Somalia and the Balkans.[31]

In preparation for Iraqi Freedom, KBR erected Army force-provider tent cities at the aerial port of debarkation and sea port of debarkation. These tent cities were erected in minimal time and provided the Army with much needed billeting and messing close to the port operations. In addition, KBR provided billeting and messing facilities at nearly every forward-deployed location in Kuwait.[32]

The Air Force IDIQ is known as the Air Force Contract Augmentation Program or AFCAP. AFCAP is a multiyear contract with readiness management support. Readiness management support has provided power generation and engineering support, built refugee camps in Kosovo, completed airfield upgrades in Ecuador, and provided backfill for deployed air traffic controllers.

The Navy IDIQ civilian augmentation program is called Construction Capabilities (CONCAP).[33] The multiyear contract with KBR has been used for dredging, communication facilities, and other activities that allow the Navy to stay within its force structure ceilings, as well as free Navy personnel for contingencies.[34]

LOGCAP, AFCAP, and CONCAP support joint US operations around the world, freeing military forces for those activities that actually require uniformed personnel. These contracts are very expensive, and the commander should ensure costs are controlled.[35] This is a task normally relegated to the contracting office; however, it is important. On the other hand, if the contractor is the only source of the service needed, it may not matter what the cost is.

Theater Support Contracts

Theater support contractors provide contracted goods and services to the deployed commander via contracts let through a deployed contracting agent.[36] Contracting officers deploy before and during the operation to procure goods, services, and minor construction from sources such as local vendors or nearby sources.[37] Theater support contracts are designed to meet the immediate needs of the deployed commander.[38] As a requirement surfaces, the deployed contracting officer can respond rapidly by using a locally established contract agreement or by way of one-time purchase orders. In either case, the contract is intended to satisfy the need and provide the commander maximum flexibility.

Host-Nation Contracts

During both Operation Desert Storm and Iraqi Freedom, the US military relied extensively on contract-let host nations via host-nation support agreements using host-nation contracting agents. These agreements permit the acquisition of goods and support from and by the host nation.[39] During Desert Storm, Saudi Arabia provided billions of dollars in support for items such as food, water, transportation, housing, and fuel. The United States would identify the requirement, and Saudi contracting officials would let a contract to satisfy the requirement.

During Iraqi Freedom, the United States relied on a similar arrangement with Kuwait. At the conclusion of Desert Storm, Kuwait and the United States established the Defense Cooperation Agreement (DCA), providing for a US presence in Kuwait for the purpose of military exercises. The DCA established the type of support the United States would provide, as well as the support Kuwait would provide, and how that support would be funded. The type of support provided by Kuwait was similar to the support provided by Saudi Arabia during Desert Storm. Just like the Saudis, the Kuwaitis negotiated some contracts on behalf of the United States, while in other cases, they allowed US contracting officers to let the contract and provided reimbursement via an account known as the Burden Sharing Account.[40]

Host-nation contracts covered the entire spectrum of support and provided the same benefits US contracts provide with the added benefit of using someone else's funding to provide support for our military. An important aspect was local contracting personnel familiar with the contracting practices unique to the Middle East let the contracts. These host-nation contracts were not without their problems.

News reports from Iraq indicate terrorists are actually targeting contractors and nongovernmental organization personnel because they are easy marks.

Problems Associated with Contracting Support

As discussed earlier, there is an increased reliance on contractors to perform mission critical tasks. Simply stated, it is impossible to deploy without them. While military personnel take an oath to support and defend, contracting personnel do not. They deploy but cannot be compelled to perform. In most cases, their only allegiance to the effort is to the corporate entity they are representing. Once Scuds start flying, the military commander cannot compel the contractor to perform. Although providing functions crucial to the combat effort, they are not soldiers. Private contractors are not obligated to take orders or to follow military codes of conduct. Their legal obligation is solely to an employment contract, not to their country.[41]

When Contractor Personnel Refuse to Perform

News reports from Iraq indicate terrorists are actually targeting contractors and nongovernmental organization personnel because they are easy marks.[2] During the Persian Gulf War, a very small number of contractors working in Saudi Arabia left the country from fear that chemical weapons might be used.[43] Many civilian contractors refused to deploy to particularly dangerous parts of Iraq at the conclusion of the heavy battle portion of Iraqi Freedom. There are reports that soldiers had to go without fresh food, showers, and toilets for months. Even mail delivery fell weeks behind.[44] Unfortunately, the compunction of a contractor or contract employee to serve in the war zone cannot be measured ahead of time, so the commander must plan for this potential outcome.[45] It is not clear that we do this well. In fact, the Government Accounting Office (GAO) reports most combatant commanders do not do this at all.[46]

In the case of military members who refuse to perform, the commander can take specific Uniform Code of Military Justice (UCMJ) actions against them. This is not the case for the contract personnel. They are not bound by or held to the UCMJ. In fact, the commander does not have jurisdiction over the contractor. The contracting officer assigned to the deployed location holds the responsibility for contract personnel. The contracting officer can notify the contracting representative of a person's refusal to perform.[47] In addition, the contracting officer can terminate the contract for failure to perform; however, if the contract is for mission-critical support, by terminating the contract, a much larger problem is created.

Dangers Posed to Contractors and by Contractors

Joint publication 4-0 states that contractors are responsible for force protection of their personnel unless contract terms place the responsibility within the DoD.[48] Regardless of where the responsibility is placed contractually, the media reports it as a US casualty, a US captive, or a US wounded without respect to who is at fault. The danger to civilians who work in the Persian Gulf was driven home in late January 2003 when two contractors from Tapestry Solutions, Inc, a San Diego firm hired by the DoD to install computer software, were ambushed in Kuwait.[49] A Brown and Root mail clerk was killed in Baghdad when a bomb detonated under his truck.[50] The military is placing contractors in harm's way, and contractors are suffering casualties. In the case of the Tapestry Solutions contractor, they were traveling from Camp Doha, Kuwait, to Kuwait City. They were not following Camp Doha policy concerning force-protection measures. They were not wearing body armor or a protective helmet. In addition, the contractors were traveling alone as opposed to the two-vehicle policy stipulated for off-post travel by the Camp Doha commander. By not traveling in a two-vehicle convoy, they provided a soft target to the terrorists. From the graphic photos displayed on the front page of the *Kuwait News* and on the Internet, it is clear that a properly worn Kevlar helmet most likely would have saved the contractor's life.

Contractors also face the risk of capture. The United States currently has three military contractors who have been held in captivity in the Colombian jungle since 13 February 2003.[51] The Revolutionary Armed Forces of Colombia captured them after their plane was shot down. This contractor was providing military training and intelligence operations in support of counterdrug operations in the region.

More recently, the threat of terrorism has raised concerns about whether it is wise for the military to use foreign workers at overseas installations.[52] This was particularly true in recent operations in Iraqi Freedom. Many of the third country nationals were from Egypt, Iran, India, Afghanistan, and other countries with heavy Islamic influence, as well as countries known to have a high number of anti-American factions within their country. In Kuwait, an effort was made to mitigate the risk by having the Kuwait Minister of the Interior, as well as the Intelligence Directorate of the Minister of Defense, conduct simultaneous background checks on the third country nationals. The Minister of the Interior was concerned with ensuring the third country national was in Kuwait with the proper identification, as well as ensuring the third country national did not have a criminal record either within Kuwait or in the country of origin. In the case of the Intelligence Directorate, it ensured the third country national did not have a heretofore-undisclosed terrorist affiliation. The United States, for its part, had differing methods of ensuring control of third country nationals. The Air Force limited the access the third country nationals had to critical areas of the base. Third country nationals could work outside the perimeter of the base unimpeded; however, any third country nationals working on base were kept under the constant surveillance of military escorts. The Army, on the other hand, checked the third country nationals as they entered the post and then allowed the third country national unescorted access to the post.

Finally, the status of forces agreement negotiated with the host nation by the State Department discusses the protection provided US personnel serving within the host nation. However, only 5 of the 109 status of forces agreements in effect have any provisions for contractors. As a result, a myriad of issues arises concerning contract personnel. These include who has criminal jurisdiction should a contractor commit a crime, whether the contractor is subject to customs charges, how long contractors may serve in a country, as well as whether they are subject to country taxes.[53] Although not a major concern of the deployed commander, these factors can lead to increased contract costs, as well as risk to the contractor.

The DoD, in concert with the Department of State, needs to ensure contractor personnel deployed in support of a contingency are covered by a status of forces agreement.

Host-Nation Contracts

Although the host-nation support contracts provide incredible flexibility, they are not without problems. First among these is the fact the Federal Acquisition Regulation (FAR) does not apply. Some feel this is not necessarily a bad thing; however, the purpose of the FAR is not to tie the commanders' hands but rather to ensure the military gets the goods and services it contracts for at a fair price, from a reputable source. Although one would hope that host-nation negotiated and funded contracts are for a fair price and from a reputable source, that is not a guarantee. In addition, the terms and conditions of the contract could prove to tie the military's hands or, even worse, be at cross purposes with the United States.

The Defense Cooperation Agreement between the United States and Kuwait stipulated Kuwait would provide food for forces deployed for Operation Southern Watch. During the preparatory phase to Iraqi Freedom, US Army and Air Force host-nation support personnel, working out of US Army Forces, US Central Command (ARCENT) FWD/S5, negotiated an extension of this contract to apply to all deployed soldiers. Further negotiation resulted in an agreement to include all military forces in the term *soldier*. However, the catering contract for US forces specifically excluded *nonsoldier personnel*, to include civilian employees and contractor employees.[54] The treatment of this portion of the contract, by both contracting personnel and the contractor, varied by deployed location within Kuwait, as well as by the military service interpreting this clause. The Army required contract and civilian personnel to sign for meals and reimburse the catering contractor.[55] The Air Force, on the other hand, did not require reimbursement. This was because the Air Force contract between deployed contract personnel and the Air Force was written such that the Air Force would provide meals for deployed contract personnel. At both Air Force locations within Kuwait, DoD civilian and contractors were not required to sign or pay for their meals. When the issue was raised by services personnel at Ali Al Salem AB, base legal personnel assigned to Ali Al Salem and ARCENT/S5 personnel agreed it was a problem, but neither could reach a reasonable solution to fix it. Although identified as an issue, the problem was not resolved by the start of the war.

Another problem with these contracts is the fact they were let by another government. The other government spelled out the requirements, and performance is managed and monitored by another government. As long as the contractor is providing the goods and services the United States wants, there is no problem; however, who has the stick should the contractor not perform? For example, at one location in Kuwait, the host-nation contractor was charging the Air Force for repair of contractor-provided equipment—equipment the contractor was required to fix per the contract with the host nation. The deployed contracting officer unwittingly let a contract directly with the contractor for repair of contractor-furnished equipment. When asked why the contracting office was doing this, they stated, "That's the way it's been done for the last three 90-day deployments." This was not only a waste of US dollars but also fraud on the part of the contractor.

Recommendations

The DoD needs to improve its visibility over contractor personnel at deployed locations, and deployed commanders need visibility of all personnel they are responsible for. It is irrelevant whether responsibility is as a result of chain of command or contract. The important issue is visibility. Visibility is important so the commander can adequately address force protection issues as well as support issues. The deployed contracting officer should maintain a database of all contract personnel with access to the deployed location and the deployed commander's responsibility with respect to the contract employee. In the case of host-nation support contract employees, the deployed commander's responsibility simply may be to provide access to the worksite. On the other hand, in the case of contractor personnel deployed from the United States in support of fielded systems, the commander may be responsible for all support necessary for the contract personnel, to include force protection.

The GAO has cited combatant commanders twice for failing to develop a contingency plan should contractors refuse to work. As stated earlier, this is not a what-if exercise—the DoD has experienced contractor personnel's refusing to work both in Desert Storm and Iraqi Freedom. Combatant commanders, as well as the Services, need to develop plans to ensure continuity of service should the contractor refuse to work. In addition, they need to analyze the impact of losing a capability should the contract personnel refuse to perform. Such a loss of sensitive equipment and systems would have a degrading effect on the deployed commander's ability to perform the mission.[56] In the case where the impact is too costly, the service should consider bringing that system support back into the force.[57]

The DoD, in concert with the Department of State, needs to ensure contractor personnel deployed in support of a contingency are covered by a status of forces agreement. Leaving contract personnel to fend for themselves could prove to be problematic, as well as costly. Getting contractor personnel to deploy to locations where they are not covered by a status of forces agreement may be even tougher. As stated earlier, 5 out of the 109 status of forces agreements the United States has contain provisions for contract employees.

According to the GAO, the amount of guidance concerning contractors deployed forward varies considerably by service. The GAO stated the Army does the best job of providing published guidance to the deployed commander and contracting officer, while the Navy and Air Force fall short.[58] Although there is a joint publication on the issue, there need to be service-specific publications for deployed commanders. This doctrine needs to cover the responsibilities of the forward deployed commander with respect to contracts. The doctrine should cover all aspects of the care and feeding of contractor personnel and who will assume responsibility.

The short duration of AEF cycles also was cited as a problem by the GAO, a problem this author experienced firsthand in Kuwait. Ninety days did not seem to be enough time for the contracting officer to become acquainted with the nuances of all the contracts the contracting officer was responsible for, let alone the host-nation contracts. The Air Force acknowledged the issue and had extended contracting personnel to Iraqi Freedom.[59] In addition, the Air Force should consider staggering the deployment and redeployment of contracting personnel serving under the contracting officer. Although this approach is counter to the AEF rotation plan, it would serve to ensure there is continuity at the deployed location.

The DoD needs to develop standard procedures for dealing with host-nation support contracts and contractor personnel. Host-nation contracts provided a significant portion of base support during Desert Storm and Iraqi Freedom. However, how well deployed forces understood the process and could work with host-nation contractor personnel was mixed at best. The Army seemed to have a better grasp on the issue, whereas the Air Force, at least in locations in Kuwait, did not seem to have a clear understanding of host-nation contract responsibilities. As a result, there were many cases where the Air Force contracting officer let duplicative contracts for a service contracted for by the host nation. In some cases, the contractor was being paid by the host nation and the United States for the same service. There were many reasons cited for the duplicative contracts, the most prevalent was the contract was set up before the current batch of contractor personnel rotated in for their 90-day rotation.

Conclusions

Since the Revolutionary War, the United States has relied on contractors on or near the battlefield. Although the DoD has experienced ebbs and flows in the use of contractors, reductions in force structure and budgets have put the DoD in a position where it is increasingly reliant on contractor support to achieve the mission. Where the contractor once was called on to perform support tasks such as long-haul trucking and mess hall support, they are now being called on to perform tasks in direct support of the mission. The increased reliance on contractors has increased their presence near and on the battlefield. Their presence has created a myriad of issues the DoD is still coming to grips with.

First among these issues is the status contractors enjoy while serving in the forward-deployed location. As stated earlier, there are only a handful of nations that include status of contractor employees in their status of forces agreements with the United States. The State Department, in tandem with the DoD, needs to address these issues with the countries where we are most likely to serve.

Second, the service doctrine needs to change to place increased emphasis on the status of forward deployed contractors. The Army has a head start on the other services, but its doctrine could serve as a boilerplate for the Navy and Air Force. This doctrine should address such issues as the force protection forward-deployed commanders will afford deployed contractor personnel. In addition, it should address the authority the forward-deployed commander has over deployed contractors should they fail to comply with published guidelines.

Third, combatant commanders should comply with the findings and recommendations put forth by the GAO to identify those critical missions currently contracted out that are so critical as to warrant developing an organic capability.

Fourth, the Services need to develop a methodology to determine whether contracting out is actually saving the military money and manpower. The Office of the Secretary of Defense should establish an office for analyzing whether the combatant commanders are actually saving by using contractor support.

Fifth, issues regarding host-nation support contracts need further clarification as well. The DoD has relied on these types of contracts during both wars with Iraq. No doubt they will be used in the future.

Finally, the combatant commander needs to develop a tool to keep track of contractor personnel in the area of operation. This may be as simple as an off-the-shelf database. The importance is not the methodology but rather the fact combatant commanders are accounting for contractor personnel deployed to their area of responsibility.

Contractors have become an integral part of the mission. The DoD is more reliant on contractors than ever before. The push to downsize the military and privatize functions means government contracts are a growth industry. The DoD needs to address issues regarding contractors on the battlefield.

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Colonel Manker is chief of Fighter and Bomber Procurement, Office of the Assistant Secretary of the Air Force, Financial Management and Comptroller. At the time of the writing of this article, he was a student at the Air War College. Colonel Williams is on the faculty at the Air War College, Maxwell AFB, Alabama.

Excellence in Writing Contest Winner

One must be aware of a significant point. During World War I, the US Army essentially built two separate and different air forces: the first, a training air force in the continental United States, the second, a combination training and combat air force in Europe. A comparison of the chaotic development of maintenance training by the Air Service in the United States with the more logical development of maintenance training by the Air Service, AEF, in France—though it was still something less than a smooth process—indicates the importance of the Royal Flying Corps/Air Service, AEF relationship to US combat capability.

logistics history

The Tail to Tooth Ratio: Royal Flying Corps and Air Service Cooperation in Maintenance Training During World War I

As America prepared to enter World War I, one thing was clear—it was incapable of sending a modern army to fight in Europe. As a result, an American presence on the Western Front could be attained only through substantial assistance from the Allied powers. From a ground warfare perspective, preparation and training would be, for the most part, in French hands. However when it came to aviation, the story would be different. The US Army turned to the Royal Flying Corps in its preparations for combat in the air. In doing so, it began a tradition of mutual cooperation that has endured on many fields of conflict to the present time. In the award winning "The Tail to Tooth Ratio: Royal Flying Corps and Air Service Cooperation in Maintenance Training During World War I," Miller examines the various approaches to maintenance and specialist training and the close interaction between US and British forces. He highlights the successes and failures in developing maintenance and maintenance training programs.

the *tail* to *Tooth* Ratio

Royal Flying Corps and Air Service Cooperation in Maintenance Training During World War I

A timely American presence on the Western Front could be attained only through extraordinary assistance from the Allied powers.

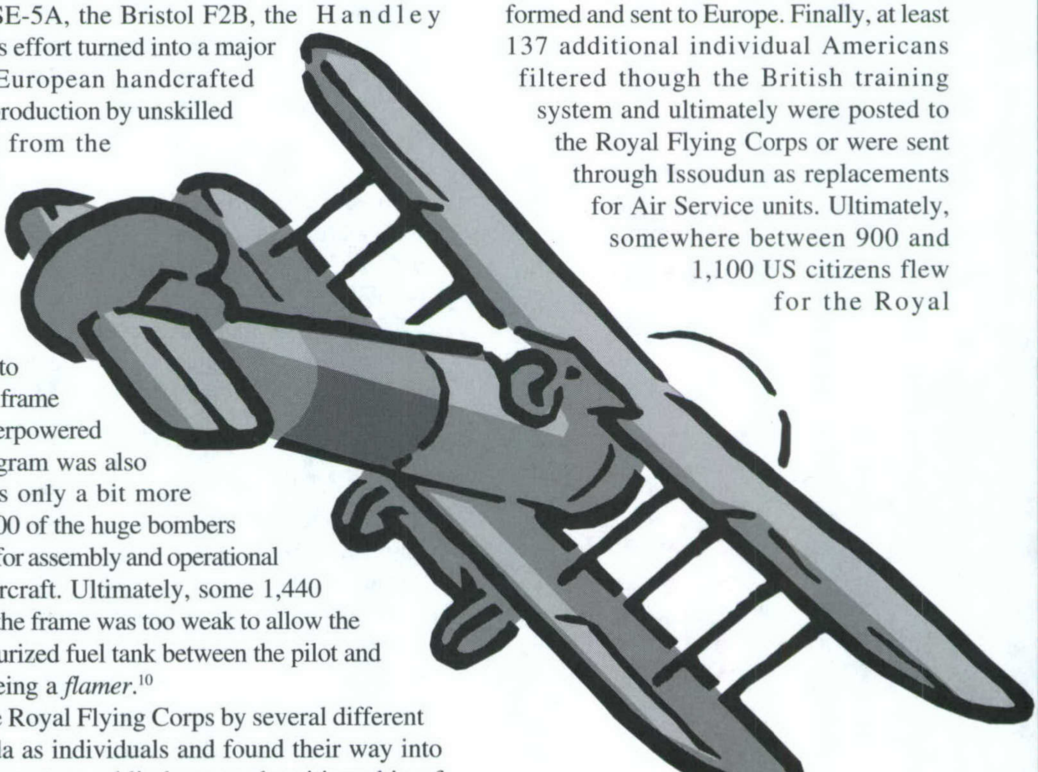
Little need exists here to detail the size, strength, and capability of the US Army at the time the United States declared war on the Central Powers in April 1917. Simply put, in every way possible, the United States was incapable of sending a modern army to fight in Europe. A British military mission that reached Washington DC a few weeks after the declaration accurately summarized the situation in four laconic, well-chosen words: "They are quite unprepared."[1] Seldom has the British talent for understatement been more appropriate. This situation, especially in the eyes of British and French leaders, would be complicated over the next year by the American determination to field a separate, independent army and stubborn refusal to *amalgamate* with the Allied armies.[2] We could spend hours discussing the controversy over amalgamation, but suffice to say that Secretary of War Newton Baker's instructions to the commander of the American Expeditionary Force (AEF), General John J. Pershing, issued on 26 May 1917, were clear and firm: "In military operations. . .you are directed to cooperate with the forces of the other countries employed against the enemy, but in so doing, the underlying idea must be kept in view that the forces of the United States are a separate and distinct component of the combined forces, the identity of which must be preserved."[3] And, as European leaders would soon discover, probably no American general between "Mad" Anthony Wayne and "Stormin" Norman Schwartzkoff could be determined more relentlessly to follow instructions—especially those he agreed with—than "Black Jack" Pershing.[4] Thus, the essential question was reduced to how best to organize, train, equip, and deploy an independent army, starting from almost nothing. The answer, readily apparent to all competent observers, was that a timely American presence on the Western Front could be attained only through extraordinary assistance from the Allied powers.

Since the United States would receive the vast majority of its modern war materials from France, the AEF would be assembled and learn its trade in the heart of France, and the Americans would take their place in the trenches on the eastern part of the Western Front, distant from the British army, it was logical that much of its preparation and training would be in French hands. Where ground warfare was concerned, this logic pretty much held true. When it came to aviation, however, the story was a good bit different. Despite the fact that the Air Service, AEF[5] ultimately would accept more than 4,800 aircraft from the French and less than 300 from the British and despite the establishment of aviation instruction centers throughout France, the US Army turned to the Royal Flying Corps (RFC)[6] in its preparations for combat in the air and, in doing so, began a tradition of mutual cooperation between the Royal Air Force and the US Air Force that has endured on many fields of conflict.[7]

The British phased system of flight instruction and RFC stress on disciplined air tactics appealed more than the French *Roleur* system and emphasis on individual flying, though both systems were used.

Several reasons underlay this development. Most important, undoubtedly, was the common language and heritage. The close presence of Canada and the role it played in the RFC training program offers another reason. Still another was the compatibility of British methods. One suspects, for example, that the British phased system of flight instruction and RFC stress on disciplined air tactics appealed more than the French *Roleur* system and emphasis on individual flying, though both systems were used. And one also must remember the affinity that quickly developed during the war among British air leaders like David Henderson, Lord Tiverton, and Sir Hugh Trenchard with Air Service leaders like Benjamin D. Foulois, Mason Patrick, and Henry H. Arnold, not to mention a persistent gadfly, who haunted higher military circles, named William "Billy" Mitchell.[8]

The story of US combat aircraft production is well-known. The Bolling Mission[9] identified British aircraft for production in the United States with a couple of exceptions, notably the Italian Caproni bomber and French SPAD pursuit. Among the British aircraft selected were the Royal Aircraft Factory SE-5A, the Bristol F2B, the Handley Page 0/400, and the De Havilland DH-4. This effort turned into a major fiasco, however. Differences between European handcrafted manufacturing and American assembly line production by unskilled labor hampered the American program from the beginning. The SE-5 program, for example, was complicated by the arrival of an incomplete sample aircraft from England, along with plans and drawings that mixed parts from three different versions of the aircraft. Only one was completed before the program was canceled. Likewise, the effort to stuff the massive 400 hp Liberty engine into the frame of the Bristol fighter failed, and three of the overpowered aircraft crashed, killing two crews. This program was also canceled. The Handley-Page program was only a bit more successful, and complete subassemblies for 100 of the huge bombers were shipped to England. None arrived in time for assembly and operational service. Only the DH–4 program yielded aircraft. Ultimately, some 1,440 Liberty-powered DH–4s reached France, but the frame was too weak to allow the Liberty to be run at full throttle, and the pressurized fuel tank between the pilot and observer gave the aircraft the reputation of being a *flamer*.[10]

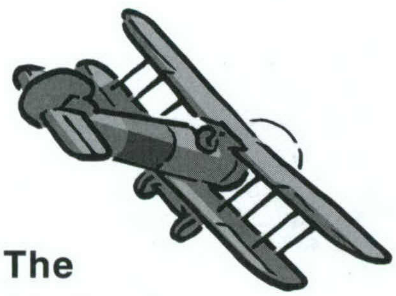


In the case of pilots, Americans joined the Royal Flying Corps by several different routes. Many crossed the border into Canada as individuals and found their way into the Royal Flying Corps, which was willing to turn a blind eye to the citizenship of suitable volunteers. More than 300 airmen entered the Royal Flying Corps through this route. Another group of Americans comprised the Oxford Group of 204 Air Service cadets sent overseas in August and September 1917. Originally destined for Italy, they were diverted to the ground school at Oxford University, went through the RFC flying training program, and joined British squadrons on the Western Front. Third, the Toronto Group included 300 cadets and 800 enlisted persons sent to Canada for training as a foundation for ten US squadrons, eight of which were formed and sent to Europe. Finally, at least 137 additional individual Americans filtered though the British training system and ultimately were posted to the Royal Flying Corps or were sent through Issoudun as replacements for Air Service units. Ultimately, somewhere between 900 and 1,100 US citizens flew for the Royal

Flying Corps, filling a huge gap in British ranks, before most transferred to the Air Service, AEF, bringing much-needed experience.[11]

The Air Service, AEF basic doctrine and operational practices were taken mostly from the Royal Flying Corps. Billy Mitchell, in France as an air observer when the United States declared war, spent several days with Trenchard, RFC Commander, touring British facilities, observing operations, and absorbing Trenchard's deep commitment to offensive operations as the bedrock of air. Subsequently, Mitchell contributed to these attributes during the St Mihiel offensive from 12 to 16 September, during which he amassed more than 1,481 Allied and US aircraft and hurled them like a mailed fist against the enemy.[12] Mitchell's stress on concentrating his air assets had a permanent impact on Air Service doctrine. In historian Tami Davis Biddle's words, "His views, reinforced by the apparent success of the autumn campaigns, would establish the principle of concentration as aerial dogma in the United States."[13] This dogma, combined with Trenchard's emphasis on the offensive, became a trademark of the American way of air warfare.

The British also guided Air Service concepts of strategic bombardment. In November 1917, Major Edgar S. Gorrell presented the new Air Service, AEF, Commander, General Foulois,[14] with a plan for bombing Germany, the main body of which was an almost verbatim copy of Tiverton's 3 September 1917 plan for long-range bombing. And later, Gorrell produced an essay, "The Future Role of American Bombardment Aviation," which included segments of Trenchard's paper on "Long-Distance Bombing" written in November 1917.[15] The two British papers contributed significantly to the doctrine of high-altitude, daylight bombardment of military and industrial targets that characterized US Army Air Forces operations during World War II and US Air Force doctrinal thinking today.



The Air Service, AEF basic doctrine and operational practices were largely taken from the Royal Flying Corps.

These are just a few examples of the impact of the close relationship between the veteran Royal Flying Corps and neophyte Air Service during World War I. Another example can be seen in the development of *maintenance* training or, what we would call today, *technical* training for enlisted personnel, which, mundane as the subject seems on the surface, is an absolute necessity in the establishment of a modern, professional air force. The Air Service maintenance training effort during World War I, however, began late, and its evolution was chaotic at best before a reasonably defined program began to emerge toward the end of the war. We need to examine this chaos a bit.

To gain an understanding of this development, one must be aware of a significant point. During World War I, the US Army essentially built two separate and different air forces—the first, a training air force in the continental United States; the second, a combination training and combat air force in Europe. A comparison of the chaotic development of maintenance training by the Air Service in the United States with the more logical development of maintenance training by the Air Service, AEF in France—though it was still something less than a smooth process—indicates the importance of the Royal Flying Corps and Air Service, AEF relationship to US combat capability.

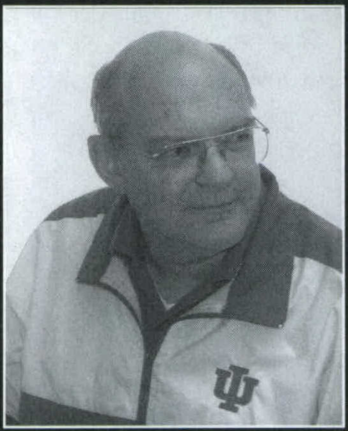
It says a lot that the United States declared war on 1 April 1917, received the Ribot cable[16] from France on 24 May 24, and passed a bill authorizing $640M for aviation on 14 July but that the Air Service did not get around to addressing the need for a formal maintenance training program until October. Until then, the Air Service largely *winged it* where training was concerned. During the first months of the war, it managed to identify and secure a reasonable number of men who either had—or at least claimed to have—some experience with machinery and some mechanical expertise. These men formed the backbone of the early aero squadrons and enabled army aviation to expand. Tested and classified according to their experience and aptitude, *trade tested* in the vernacular of the day, these men learned on the job and enabled army aviation to expand rapidly without developing formal training for mechanics and technicians.[17]

While many of the enlisted men had mechanical experience and could learn on the job from the few experienced personnel available, this approach was not economical at best and useless at worst, as large numbers of inexperienced people entered the service. And it was apparent that even the most knowledgeable mechanics needed training on the peculiarities of aviation engines and airframes. Some knowledge and skill was transferable from civilian jobs, and experienced men could adapt easily. Automobile engine mechanics, for example, could learn aero engines without great difficulty, and wood workers would have little trouble working with airframes. Greater problems were posed by specialists such as sheet metal workers, welders, and tinsmiths who were in short supply. Finally, individuals experienced with skills peculiar to aviation, such as propeller makers, were extremely rare, and drafting the few available would hamper aircraft production. Everything pointed toward the need for an extensive technical training program, but this took time to develop.

Mechanics who made up the earliest squadrons mostly learned through on-the-job training at the various flying fields. Such instruction, however, tended to be haphazard and superficial, especially since, thanks to the shortage of construction troops, most of the early squadron personnel also had to construct barracks, hangars, administrative buildings, and other airfield infrastructure in addition to accomplishing other duties. The Air Service did its best, even publishing in August 1917 a training manual that prescribed a 10-week, on-the-job course of practical instruction in electricity, airplanes, gasoline engines, office work, and telegraphy.[18] This attempt to standardize had merit, but ad hoc, on-the-job training programs were not going to meet expanding Army aviation requirements.

In October 1917, the Air Service turned to private industry for assistance, asking a number of civilian factories to admit enlisted personnel and train them in several specialties where severe shortages existed. This approach had a number of advantages. Enlisted personnel would get extensive training from experienced civilian technicians, while the factories would benefit from the influx, even if temporary, of trainable, largely enthusiastic workers who did not have to be paid by the company. The first 25 enlisted men joined an oxyacetylene company on 11 November 1917 for a 3-week course on welding. By the end of the month, an additional 300 or more men had entered companies where

Roger G. Miller, PhD



Dr Miller is a historian and the director of the Contract History Program for the Center for Air Force History headquartered at Bolling AFB in Washington DC. A native of San Antonio, Texas, Dr Miller earned his bachelor's and master's degrees at North Texas State University in Denton, Texas, and his doctorate at Indiana University, in Bloomington, Indiana.

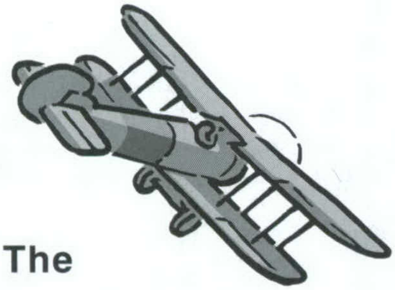
A former officer in the US Air Force, Dr Miller entered the Air Force history program in 1980. As a historian, he has served at Lowry Technical Training Center, Denver, Colorado; Headquarters Air Training Command, Randolph AFB, Texas; Headquarters Seventeenth Air Force, Sembach AB, Federal Republic of Germany; and Headquarters US Air Force in the Pentagon. He joined the book-writing program in the Center for Air Force History in January 1993. Among his responsibilities, Dr Miller writes, publishes, and lectures widely on many aspects of airpower history. His primary areas of interest include air logistics, air transportation, and early military aviation history.

Dr Miller's most recent book, *To Save a City: The Berlin Airlift, 1948-1949*, was published by Texas A&M University Press in November 2000, and his articles and reviews have appeared in the *Journal of American History*, *Indiana Magazine of History*, *Military History*, *Air Power History*, *The Public Historian*, *Prologue*, *The Journal of Air Force Logistics*, and *Camaraderie*. His most recent contributions to the Office of Air Force History monograph series include *A Preliminary to War: The 1st Aero Squadron and the Mexican Punitive Expedition of 1916* and *Billy Mitchell: Stormy Petrel of the Air*, both published in 2004. Dr Miller is currently writing a full-length biography of World War II air leader Lieutenant General Lewis Hyde Brereton.

they learned 14 different technical specialties. Pleased with the success of the initial courses, the Air Service extended the program on 15 January to the aircraft, aviation engine, and tire industries. In all, more than 30 companies eventually took part in this program, training more than 2,000 mechanics and specialists.[19]

About the same time, winter closed the flying training programs at Chanute, Hazelhurst, Scott, Selfridge, and Wilbur Wright Fields. On 1 November 1917, Air Service officials decided to use these facilities for technical instruction. The Air Service advertised for experienced personnel from industry for instructors. Seventeen applicants became officers, 48 received enlisted rank, and 5 became aviator *mechanicians*. They then received 3 weeks of military training at Selfridge Field. The five schools opened on 1 January 1918 with about 315 students, but some slippage took place between plans and performance. From the first, the five schools were hampered by a shortage of instructors and equipment, the severe winter weather, and a measles epidemic. By the time they ceased operation on 1 April 1918, however, these fields had produced 574 engine and 1,120 airplane mechanics, 939 motor transport specialists, and 30 welders.[20]

In December 1917, Air Service planners explored the expansion of maintenance and specialist training through civilian vocational schools. A detachment of enlisted students arrived at the Dunwoody Industrial Institute in St Paul, Minnesota, on 10 December. The initial courses proved excellent, and on 1 January 1918, the Liberty Engine Ignition School opened under the supervision of five of Dunwoody Institute's best instructors. Subsequently, the Institute taught courses that ranged from aircraft and motor maintenance to instrument repair. Additional courses opened at the Carnegie Institute of Technology in Washington DC on 25 January for coppersmiths, blacksmiths, and motor and aircraft repairmen; at the Pratt Industries, in Brooklyn, New York, on 18 March for carpenters, cabinetmakers, and motor mechanics; and at the David Rankin School of Mechanical Arts in St Louis on 1 March for carpenters, blacksmiths, electricians, metal workers, propeller specialists, and motor mechanics. The use of vocational schools proved highly successful, and the Air Service soon incorporated the training at St Paul as a permanent part of its wartime technical training program.[21]



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Finally, in mid-November, the Air Service established the Enlisted Mechanics Training Department at Kelly Field near San Antonio, Texas. Initially, this effort bordered on farce. Kelly authorities designed a program for 320 men and set it up in eight hangar tents, each with an aircraft, engine, and instructor. Three days later a Texas *norther* blew everything down. The officials immediately reestablished the program in two metal hangars, but then no students came. The Kelly Field commander appealed to the commander of the US Army's Southern Department, who ordered every squadron forming at Kelly to furnish a cadre of trainees. The squadrons immediately furnished 3,000 men who, first, were not the best men in each unit and, second, completely overwhelmed the program with their numbers. Directed to return to their units, the men responded by stripping the engines and airplanes of parts as souvenirs of the experience. Unsurprisingly, on 29 December, Army inspectors closed down the program. Opened again in January 1918, the school still proved unsatisfactory. Kelly officials then revised the curriculum, provided increased quantities of training equipment and reference materials, put the instructors through an extensive training course, and reopened the program once again on 18 March. The revised program was successful, and by 30 June 1918, it had graduated 419 airplane and 300 motor mechanics, as well as 195 motor transport specialists. These men ultimately were rated as some of the best technical personnel sent to the flying squadrons in the United States and in France. Subsequently, the Air Service expanded the program to a capacity of 1,000 students. Renamed the Air Service Mechanics School, it became the foundation for the technical training system operated by today's Air Force.[22]

It is important to note that the men who went through these programs received general rather than system-specific training. In the case of engine mechanics, for example, they trained to work on *an* aero engine, not necessarily *the* aero engine that they would find when they reached the flight line. This was less true for mechanics assigned to flying fields in the United States, who usually received instruction on the ubiquitous Curtiss and Hall-Scott engines, especially after these became available in large numbers in early 1918. But many mechanics who had never touched anything but a Curtiss OX-5 suddenly found themselves confronting the mysteries of the geared Hispano-Suiza V-eight, the water-cooled radial Salmson, or the air-cooled Gnome and Le Rhône rotaries, in which the entire engine spun around its own crankshaft. These men still had to learn on the job, adapting their general knowledge to the peculiarities of whatever equipment their unit operated. In the last few months of the war, however, the Air Service addressed this deficiency by establishing specialized schools at various factories where engines were being built, including the Liberty Motor School in Detroit, Michigan; the Hispano-Suiza School at New Brunswick, New Jersey; and the Le Rhône Engine Course at Swissvale, Pennsylvania. System-specific instruction also took place in the Ignition Course at the Splitdorf Magneto Plant at Newark, New Jersey; the Instrument Course taught at Langley Field, Virginia; and the Handley-Page School at the Standard Aircraft Corporation in Elizabeth City, New Jersey.[23]

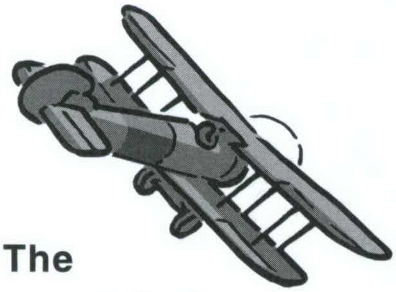
In summary, by June 1918, the various approaches to maintenance and specialist training had succeeded in meeting the Army's most serious requirements in the United States and in France, enabling the Air Service to concentrate the body of its formal technical training programs at the Air Service Mechanics School at Kelly Field and the Dunwoody Industrial Institute. These programs functioned until the end of the war. Altogether, the different programs graduated 14,176 enlisted mechanics and technical persons by 11 November 1918.[24]

Now, where does the Royal Flying Corps come into all this? The Air Service made an early effort to establish its own maintenance training program in France; however, this approach quickly fell apart because of a lack of facilities, training equipment, and instructors. Thus, what training initially took place in Europe was on-the-job at the various flying fields and repair centers, and the Air Service turned to France and England to fill the mechanics training gap. The French Government proved much less helpful in this regard than in other areas. At the request of the French, in 1917, the Air Service, AEF ordered some 475 enlisted persons to French flying fields for instruction, while another 200 aero mechanics were sent to work in French aircraft factories where they received practical experience, if not formal training. These men served in the factories until Foulois requested their return in January 1918. But this was just a drop in the bucket compared to the number required—and the number trained with British assistance.[25]

What training initially took place in Europe was on-the-job at the various flying fields and repair centers, and the Air Service turned to France and England to fill the mechanics training gap.

Help from Great Britain began in the United States when the Air Service took advantage of a training program already in existence. In July 1917, Colonel Cuthbert G. Hoare, commander of the Royal Flying Corps in Canada, proposed a reciprocal training program in which the Royal Flying Corps would train ten American squadrons in Canada in exchange for the use of three flying fields in the United States for winter training when weather closed many of the fields in Canada. The Air Service accepted the offer and built three fields at Camp Taliaferro near Fort Worth, Texas. Subsequently, Hoare offered to train an additional eight squadrons in exchange for extended use of these fields. Eight of the first ten squadrons trained under this program saw operational service in France; however, the process was hardly as straightforward as it seemed on the surface. Ultimately, the Canadian program trained some 4,800 American pilots, ground officers, and enlisted persons. It was a successful program but answered only a part of the need for trained mechanics.[26]

The concept of swapping training in exchange for warm bodies lay at the bottom of the most extensive training program established overseas during the war. Major Raynal C. Bolling had discussed training American mechanics with British authorities while the Bolling Commission was in England in June 1917, and in September, shortly after the first American air units reached France, several detachments in transit to France were diverted to England for instruction on British aircraft. These included the 34th Aero Squadron and 50-man detachments from seven other squadrons. These were joined in October by five additional flying squadrons and several construction units. Subsequently, negotiations between Pershing and the British Air Ministry led to the Mechanic Training Agreement signed on 5 December 1917. This agreement provided that the Air Service would send 15,000 mechanics to England by 1 March 1918 for training by the Royal Flying Corps. Their presence would release a corresponding number of British mechanics for service at the Front. When trained, the American mechanics would be released to the Air Service, AEF in France at the same rate that they were replaced in England by new trainees from the United States. The agreement also called on the Air Service to furnish 6,200 American construction persons—including carpenters, bricklayers, and laborers—to work on RFC flying fields.[27]



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Shipping problems handicapped the program from the beginning, however, and only 3,931 mechanics had reached England by 1 March 1918, the date by which all 15,000 were supposed to be on hand. Then, the German spring offensive forced Allied and American leaders to revise the shipping schedules in favor of ground troops, further delaying the arrival of trainees.[28] Shortages of shipping also interrupted the transport of construction personnel. As a result, the planned total of 15,000 men in training was not reached until August. Despite such problems, however, the British mechanics training program made an absolutely vital contribution to the development of the Air Service, AEF capability in France. As of 30 May, the Air Service had 73 flying squadrons, 18 repair squadrons, and 3 supply squadrons, mostly at British flying training fields. Almost all the men in the flying squadrons had some experience with Curtiss JN–4 *Jennies* and their OX-5 engines at American training fields. In England, they gained valuable knowledge on a wide variety of combat engines and airframes similar to those they would service in France.[29]

An officer who visited 15 training centers in England observed American mechanics doing "every class of skilled work required in connection with an aerodrome."[30] Inspectors who reviewed the program concluded that the Americans were more technical-minded than their British counterparts and had greater enthusiasm and higher morale—hardly surprising given that Britain was in its fourth year of seemingly unending bloodshed. Early shortages of training equipment, facilities, and experienced instructors took time to solve but were overcome. One problem proved impossible to resolve. Americans disliked English food. Most, one could say with some accuracy, would walk a mile for American canned *monkey meat* rather than indulge in English cuisine. And when it came to tea, the word *despised* suggests itself. Then, as now, *kippers* were hardly an American breakfast staple, and the US Army ran on coffee. Of greater significance, however, both British and American officials had a tendency to lose sight of the fact that training was the primary goal of the program. Too many wanted to treat the men as permanent replacements for British mechanics. Additionally, the dispersal of units across England made the program difficult to manage and forced the Air Service to establish an organization to track progress. Adoption of a reasonably standardized 3-month training scheme aided in this effort, as well. In June 1918, the Air Service also developed a standard squadron organization for the units in England, which through the addition or subtraction of 10 percent of its people could be modified into any type of flying squadron required. Still, it might have been more efficient and less disruptive to manage the program by individuals rather than squadrons. Requests could have gone to England by specialty. Officials in London then would have filled those requests by selecting the best trained personnel from the locations where they could best be spared. These then would be sent to St Maixent in France where the aero squadrons were organized and equipped.[31]

By May 1918, Air Service officials faced a serious shortage of mechanics in France and sought to draw on those in England. British air leaders, however, had become dependent on American manpower and opposed releasing American units until replacements had arrived in accordance with the 5 December 1917 agreement. "I am thoroughly convinced that if tomorrow the majority of American squadrons were to be removed from England," 1st Lieutenant T. P. Walker of the Air Service reported, "the Royal Air Force would be severely crippled, and at certain stations, their training would come to a complete standstill."[32] To resolve the problem, General Patrick, new chief of the Air Service, AEF,[33] met with the British air officials in London "and placed our situation clearly before them." Bowing to American needs, the British agreed to release 3,500 mechanics who, Patrick agreed, would be replaced as quickly as replacements from the States became available.[34]

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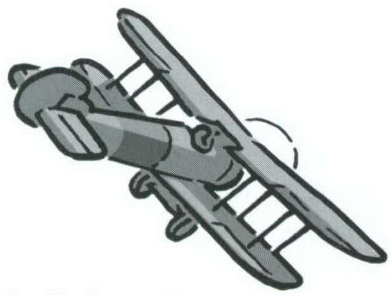
In June 1918, the first five squadrons—the 49th, 50th, 93d, 135th, and 213th Aero Squadrons—left England for France. As of 1 July, 72 squadrons were judged trained, and over the next few months, many of these rejoined the Air Service, AEF. All in all, the program provided a huge boost in trained maintenance personnel for the Air Service in France, as well as essential manpower for the Royal Flying Corps. The English program ultimately trained 22,059 men, of which 11,170 were sent to France. At least 18 of the 45 flying squadrons that fought with the Air Service on the Western Front received a major portion of their training in England. Other squadrons manned assembly plants, repair depots, flying fields, and airparks. Of those remaining in England, several were diverted to man the Handley-Page development program described below. Still others were in the personnel pipeline flowing to the Front when the armistice took effect.[35]

A large number of mechanics remained stuck in England, however, tied up by a program that, had the war lasted into 1919, might have led to an Air Service strategic bombing capability. The Handley-Page program grew out of the American desire to develop its own long-range bomber force. On 26 January 1918, Foulois signed an agreement with the British that provided for the manufacture in the United States of enough twin-engine Handley-Page bombers—powered by Liberty engines and equipped with all weapons, instruments, and accessories—to equip 30 American squadrons. These would be shipped to England in prefabricated pieces and assembled at production plants built especially for that purpose. The program also required shipping American personnel to England to construct the facilities required for the program, as well as providing enough mechanics to be trained to maintain the big airplanes. Final training for the squadrons would take place at several airfields in England.[36]

Work on the project began immediately. Assembly plants were established in two cotton mills near Oldham, and five airfields were identified as training sites. The Air Service shipped some 3,000 carpenters, bricklayers, and laborers to England to prepare these facilities. Instruction for the flying squadrons began at sites in the United States and continued in England using ten Handley-Page bombers borrowed from the British, powered by Liberty engines loaned by the US Navy. Unfortunately, as already noted, the project came to naught. First, the same kind of design and fabrication problems that delayed production of the De Havilland DH–4 and other aircraft afflicted the Handley-Page program. The big bomber comprised more than 100,000 parts, and construction was parceled out to several companies. But American industry proved incapable of making such a system function, and production quickly fell months behind schedule. By November 1918, only about 95 percent of the parts for 100 aircraft and less than 50 engines had reached England. Second, less than 60 percent of the production and assembly personnel reached England. Finally, bad weather, conflict with British trade unions, and frequent strikes delayed construction of the assembly facilities.[37] The one part of the program that worked well, unfortunately, was the shipping of several thousand potential mechanics to England for training. There they remained, waiting for aircraft that never arrived. Colonel Henry H. Arnold, later commander of the US Army Air Forces during World War II, concluded, "The only result [of the Handley-Page program] was that the American air outfits in France were deprived of their needed services."[38]

Despite all the training programs in the United States, England, and France, the Air Service never completely got a handle on maintenance personnel. The problem lay in two spheres, the malassignment of trained mechanics and the need to use them to accomplish additional military roles. Colonel Walter C. Kilner, chief of the Training Section for the Air Service, emphasized the deficiencies in trade testing, which was, all too often, done by Army officers with little knowledge of what they were doing. Trade testing, he asserted, should be done by experts in those trades, and he singled out the squadrons formed at Kelly early in the war as examples.

> Wood workers were rated as machinists, farmers as mechanics, and good machinists were given fatigue duties. Clerks were made mechanics, and good mechanics were made clerks, and then the entire squadron would be turned over to a supposedly technical officer for further training and assignment to duty. Under such conditions, it is not strange that mechanical work progressed slowly and that much of it was not properly done.[39]



Captain Charles W. Babcock, chief aeronautical engineer at the Third Aviation Instruction Center at Issoudun, reported that an improper distribution of mechanics plagued his maintenance efforts until the end of the war, and expert mechanics often were unavailable for duty because they were doing kitchen police, guard duty, or other labor.[40] The problem extended to specialists of all types. In August 1918, newly assigned 2d Lieutenant R. H. Wessman, armament officer of the 50th Aero Squadron, found his 13 armorers away from their duty stations "doing all kinds of fatigue work." Then, when he finally mustered his troops, he discovered that only three had any training for their duties.[41] Other units, like the 90th Aero Squadron, fared much better: "Specialized training was necessary," the unit history later stated about its enlisted men, "but nearly all were by trade expert mechanics, who had volunteered for the work to which they were assigned and who were enthusiastic over the prospect of doing their *bit* along the lines for which they were peculiarly fitted."[42]

In July 1918, the Air Service formalized the process for assigning mechanics to the flying squadrons and forming squadrons in France. While most of the earlier squadrons had arrived more or less intact, deficiencies in their organization, the process of sending thousands of airmen to Europe for training, and the need for all pilots to receive flying training after they reached Europe had fragmented the squadron *mobilization* process. On 16 July, Patrick directed that all ground officers and enlisted men arriving in France, especially from the schools in England, would go to the Air Service Replacement Concentration Barracks at St Maixent. At St Maixent, the Air Service established a barracks, storage building, and trade center convenient by railroad to the main AEF base ports. There the new arrivals were trade-tested, given additional instruction, issued the correct personal equipment from the stocks maintained there, and reorganized into units as required. Once prepared, the units were sent temporarily to Orly, Romorantin, or one of the flying training centers. At these locations, squadron personnel augmented the permanent workforce, gaining in the process additional familiarity with their duties. From there, most units moved to the 1st Air Depot at Colombey-les-Belles where they met their new commanding officer, received contingents of Ordnance and Medical Department personnel, and secured all required squadron equipment and transportation. Airplane and motor spares were divided into squadron lots, park lots, and reserve lots, and shipped to the 1st Air Depot where they were issued to the squadrons and airparks

Deficiencies in their organization, the process of sending thousands of airmen to Europe for training, and the need for all pilots to receive flying training after they reached Europe had fragmented the squadron *mobilization* process.

as appropriate. A second reserve lot was sent to the Air Service, AEF spares depot. Pilots came from Issoudun and aircraft from the depots, acceptance field, or production center. The fully equipped squadrons were then directed to their front-line destination as complete units. As of 10 August 1918, the Coordination Section at Air Service Headquarters managed all aspects of this process. Section personnel knew at all times where each element was that made up a particular squadron, enabling them to anticipate requirements at each stage of the mobilization process, monitor developments, and massage any problems. The Air Service now had the ability to send squadrons to the Front according to a preplanned schedule rather than haphazardly as before.[43]

In summary, starting from almost nothing in April 1917, the United States had developed a modern, by contemporary standards, air force capable of providing minimum support to the field army operating on the Western Front. Within the United States, as has been discussed, the Air Service operated a training air force that provided itself with instructor pilots and the AEF in France pilots with basic flying skills. One part of the original program was never completed: the failure of American industry to produce suitable aircraft prevented establishing a complete training program at home and shifted the main burden of advanced flying training to France. The buildup of the Air Service in Europe had begun slowly but accelerated dramatically during the last 4 months of the war. The final numbers cannot be reconciled totally with confidence, but as of the last day of the war, the Air Service in France had received 6,364 aircraft: 19 from Italy, 258 from England, 4,874 from France, and 1,213 from the United States.[44] Some 2,698 service aircraft had been sent to the Zone of Advance, while 714 service aircraft remained at the main depots and acceptance parks. Of those sent to the Zone of Advance, the operational flying squadrons had received 2,495 aircraft, while 203 remained in the advance air depots. Attrition had been high, and 1,627 service aircraft had been lost through accident or combat.[45]

Within the United States, as has been discussed, the Air Service operated a training air force that provided itself with instructor pilots and the AEF in France pilots with basic flying skills.

At the armistice, the 45 squadrons of the Air Service, AEF at the Front were capable of providing reasonable reconnaissance and bombing support for the ground troops and aerial defense for itself. On the other hand, the size and strength of the AEF at that time actually justified a much larger air force, more than 100 squadrons. Further, the 45 squadrons at the Front were terribly under strength, fielding only 457 operational aircraft out of an authorization for more than 700.[46] In part, this was a result of the heavy losses during the Meuse Argonne fighting. In part, it resulted from difficulties with the type of equipment available like, for example, the complex and delicate, Hispano-Suiza-geared 220 hp engine that powered the Spad XIII. In part, it reflected a shortage of replacement aircraft, spares, and parts from the hardpressed French. But in part, it also was a result of the weaknesses in the maintenance training program that had taken so long to develop. World War I, in short, presented the US Air Service and its successor organizations with mixed results. Thanks to the assistance from the European allies, especially the Royal Flying Corps, it had come an incredibly long distance in an extremely short time. Yet, at the armistice, many weaknesses remained, and much more needed to be accomplished. Perhaps, it is most accurate to say in summary that a foundation for the future had been established, but little more.

Notes

1. Quoted in Edward M. Coffman, *The War to End All Wars: The American Military Experience in World War I*, The University of Wisconsin Press, 1986, 11. Coffman remains, perhaps, the best single-volume study of the US experience during World War I.
2. On amalgamation, see Coffman, 9-10.
3. Quoted in John J. Pershing, *My Experiences in the World War*, 2 vols, New York: Frederick A. Stokes Company, 1931, I, 38

4. The standard biographies of Pershing are Donald Smythe, *Guerrilla Warrior: The Early Life of John J. Pershing,* New York: Charles Scribner's Sons, 1973, and Donald Smythe, *Pershing: General of the Armies,* Bloomington: Indiana University Press, 1986.
5. For clarity, the term Air Service in this article refers to the military aviation establishment in the continental United States, and the term Air Service, AEF refers to that in Europe. The distinction is indicative of the division in US military aviation at the time. Military aviation in the United States began under the Aeronautical Division of the Signal Corps and remained under that branch of the service until 1918, although the name of the office changed several times. On 20 May 1918, aviation was separated from the Signal Corps and embodied in two organizations, the Director of Military Aeronautics and the Aircraft Production Board. These two, known already as the Air Service, finally were combined into a single organization on 27 Aug 18. In contrast, Pershing separated aviation from the Signal Corps in the AEF in July 1917. The establishment in France, thus, became the Air Service, AEF and continued under that name throughout the war.
6. Again, for clarity, the Royal Flying Corps became the Royal Air Force on 1 Apr18, but this article will use RFC throughout. RAF will be used to refer to the service after the war.
7. John H. Morrow, Jr, *The Great War in the Air: Military Aviation from 1909 to 1921*, Washington DC: Smithsonian Institution Press, 1993, 338. See also Lee Kennett, *The First Air War*, 1914-1918, New York: The Free Press, 1991. On the US Air Service during World War I, see Arthur Sweetser, *The American Air Service: A Record Its Problems, Its Difficulties, Its Failings, and Its Achievements,* New York: D. Appleton, 1919; Lt Lucien H. Thayer; *The Official History of the US Air Service, AEF (1917-1918)*, ed by Donald J. McGee and Roger J. Bender, San Jose, California: R. James Bender Publishing, 1983; James J. Cooke, *The US Air Service in the Great War,* Westport, Connecticut: Praeger, 1996.
8. Rebecca Hancock Grant, *Training to Fly: Military Flight Training, 1907-1945*, Washington DC: Air Force History and Museum Program, 1999, 101-99, describes the development of Air Service flight training programs during World War I.
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10. Morrow, 268-71, 321, 340-43. For extensive examination of US manufacturing failures, especially in aviation, see, Benedict Crowell, *America's Munitions*, 1917-1918, Washington DC: Government Printing Office, 1919, and I. B. Holley, Jr, *Ideas and Weapons: Exploitation of the Aerial Weapon by the United States; A Study in the Relationship of Technological Advance, Military Doctrine, and the Development of Weapons*, New Imprint, Washington DC: Office of Air Force History, 1983.
11. James J. Sloan, Jr, *Wings of Honor: American Airmen in World War I*, Atglen, Pennsylvania: Schiffer Military/Aviation History, 1994, 104-107.
12. Morrow, 336, 337. Mitchell's activities during the St Mihiel offensive are detailed in James J. Cooke, *Billy Mitchell*, Boulder, Colorado: Lynne Rienner Publishers, 2002, 84-94.
13. Tami Davis Biddle, *Rhetoric and Reality in Air Warfare: The Evolution of British and American Ideas About Strategic Bombing, 1914-1945*, Princeton, New Jersey: Princeton University Press, 2002, 53.
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15. Biddle, 53-56.
16. Alexandre Ribot was the French premier. His cable called for the United States to produce 4,500 planes, 5,000 pilots, and 50,000 mechanics and became the basis for early Air Service planning.
17. Hiram Bingham, *An Explorer in the Air Service*, New Haven: Yale University Press, 1920, 59-60; Sweetser, 140-41.
18. Royal D. Frey, "Evolution of Maintenance Engineering, 1907-1920," Historical Study No 327, Historical Division, Air Materiel Command, Jul 60, 83.
19. Frey, 86-87.
20. Sweetser, 143-44; Lt F. J. Pendergrast, "History of the Air Depot at Fairfield, Ohio, 1917-1943," 6-7, Microfilm Reel A2107, Frames 186-626, Air Force Historical Research Agency (AFHRA), Maxwell AFB, Alabama.
21. Frey, 88-89.

22. Henry H. Arnold, "Aviation Section, Signal Corps, and Division of Military Aeronautics, April 1917-October 1918," nd, 10, 168.65011-4, Ernest L. Jones Collection, AFHRA; Sweetser, 144; Frey, 85-86.
23. Frey, 106.
24. Frey, 89-90.
25. Maj Gen Mason M. Patrick, "Final Report of the Chief of the Air Service, AEF," in Maurer Maurer, ed, *The US Air Service in World War I*, 4 vols, Washington, DC: Office of Air Force History, 1978, I, 55, 58-59; Memo, Maj Birdseye B. Lewis, Materiel Division, Air Service, AEF, to ACA, 25 Sep 17, atch to Supply Section Questionnaire, 4 Jan 19, Box 4, the papers of Col Halsey Dunwoody, AFHRA.
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30. Memo, 1st Lt T. Walker, to chief of Personnel, Air Service, AEF, subj: American Squadron Training in England, nd, Series A, Vol 15, Roll #4, Gorrell.
31. Walker; Frey, 137-44, 168.
32. Walker.
33. Maj Gen Mason M. Patrick, an engineer and nonflyer, replaced Foulois as Chief of the Air Service, AEF on 29 May 18. He served in that capacity through the armistice.
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35. Thayer, 252-53; Frey, 146.
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38. Henry H. Arnold, *Global Mission*, New York: Harper & Brothers, 1949, 71.
39. Col Walter C. Kilner, Chief, Training Section, in Maurer, *US Air Service*, IV, 328.
40. Capt Charles W. Babcock, Chief, Aeronautical Engineer, Third Aviation Instruction Center, in Maurer, *US Air Service*, IV, 244.
41. 2d Lt R. H. Wessman, armor officer, 50th Aero Squadron, in Maurer, *US Air Service*, IV, 234.
42. Leland M. Carver, Gustav A. Lindstrom, and A. T. Foster, *The Ninetieth Aero Squadron, American Expeditionary Forces*, Hinsdale, Illinois: E. Harold Griest, 1920, 10.
43. Supply Section Questionnaire, 4 Jan 19, 28, Box 4, Dunwoody Papers, AFHRA; Maj Gen Mason M. Patrick, "Final Report of the Chief of the Air Service, AEF," in Maurer, *US Air Service*, I, 73, 78; Toulmin, *Air Service, AEF*, 130-32, 234; Air Service Memo No 22, 16 Jul 18, and Memo No 44, 10 Aug 18, which set up the squadron mobilization process are reprinted in Toulmin, 118-22, 125-27.
44. "Statistics with Relation to Supply as of 11 Nov 18," Box 3, Dunwoody Papers, AFHRA.
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46. Morrow, 338.

EXPLORING THE HEART OF LOGISTICS

Deploying Expeditionary Medical Assets

Captain Robert E. Overstreet, USAF

While the mission of the Air Force Logistics Management Agency (AFLMA) is to enhance logistics efficiency and effectiveness, we have focused primarily on the flight-line side of logistics. A refreshing change came in early April 2003 when the Air Force Surgeon General requested that AFLMA study the establishment of central war reserve materiel (WRM) storage and deployment centers. He stated that the lighter equipment packages that make up the Expeditionary Medical Support (EMEDS) and aeromedical evacuation systems have created transportation challenges.[1]

The EMEDS system was built in 1999 to replace the large air-transportable hospital. This new system—a lightweight, rapidly deployable, modular medical capability—is flexible enough to respond to any scenario.[2] It follows a building-block approach to attain medical capability in theater. Much of the initial EMEDS medical capability is composed of care providers with backpacks, the Prevention and Aerospace Medicine Team, Mobile Field Surgical Team, and the Expeditionary Critical Care Team. The ten-man small portable expeditionary aeromedical rapid response (SPEARR) capability is completed by the addition of the SPEARR trailer, which contains one tent with equipment and supplies. The EMEDS basic brings with it 15 more persons, two shelters, supplies, and equipment. EMEDS +10 contains 31 persons, three more shelters, and ten inpatient beds. EMEDS +25 contains 30 persons, three more shelters and 15 inpatient beds. The EMEDS capability can continue to expand with additional ten-bed packages or specialty sets. Figure 1 depicts how this capability is built based on population at risk, the number of persons for which the Air Force provides medical care.

The EMEDS system unit type codes (UTC) are stored at and deployed from many different medical treatment facilities, both in the continental United States (CONUS) and overseas. Because of the large number of origins and different aerial ports of embarkation (APOE), the time phasing of the EMEDS and aeromedical evacuation UTCs during Operation Enduring Freedom and Operation Iraqi Freedom were problematic.

The objectives of this study were to quantify the problems experienced in the deployment of EMEDS and aeromedical evacuation UTCs, identify the root causes of those problems, evaluate possible solutions, and provide a recommended solution to the Air Force Surgeon General's Office.

We assumed that only the UTCs identified by the Air Force Medical Logistics Office (AFMLO) were candidates for consolidation, and we were concerned only with CONUS-based UTCs. This study made no attempt to validate or invalidate the EMEDS or aeromedical evacuation concepts.

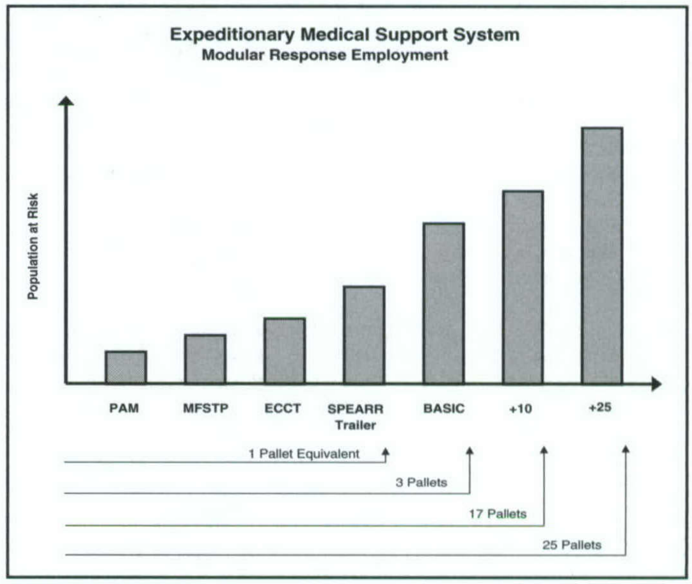


Figure 1. Expeditionary Medical Support System

Limited time and conceptual complexity were significant constraints for this study. AFLMA was asked to provide initial recommendations within 4 months of its first meeting with the AFMLO. The complexity of the EMEDS and aeromedical evacuation consolidation issue could have justified multiple studies easily.

The AFMLO scoped the project to an evaluation of 31 UTCs that deployed from the CONUS and identified two consolidation options. The first option was the establishment of a central hub located at KellyUSA, and the second option was the establishment of a dual hub with one located on the east coast and the other on the west coast. They also provided copies of the time-phased force deployment data (TPFDD) for Enduring Freedom and Iraqi Freedom.

This research sought to analyze the problem UTCs identified by the AFMLO and Air Mobility Command (AMC); gather and analyze TPFDD and aerial port data to investigate problems; and once problems were determined, review possible solutions to include central storage of medical WRM. We interviewed subject-matter experts, collected and analyzed cost data (storage, manpower, and contract), and evaluated the training and mission impact of possible solutions by interviewing and observing the participants in the process.

To that end, this study relied heavily on the qualitative research design. The qualitative paradigm is an inquiry process of understanding a problem or process by building a complex, holistic picture, conducting research in the natural setting, and expressing the results in narrative form.[3]

AFMLO provided the Enduring Freedom and Iraqi Freedom TPFDDs for analysis. We reviewed these and found what seemed to be capability being requested out of sequence. During our site visit at US Air Forces, US Central Command, we asked why capability was requested in such a manner. Functionals explained that the capability had been requested correctly but, if an item missed a ready-to-load date at the origin or an available-to-load date at the APOE, the original line in the TPFDD was deleted, and a new line with a new required delivery date was established. Because of deleted requirements in the TPFDD and new required delivery dates being established when a UTC missed a key transportation date, we determined that an evaluation of the transportation data received from AMC would not provide reliable information.

Interviews with functional representatives from civil engineering, communications, and security forces suggested that they experienced similar transportation problems. We identified the root causes of these problems as constrained airlift, intransit visibility issues, and a high number of deployment points of contact. Of these, only the number of points of contact can be addressed directly by the medical community.

Possible solutions include keeping these UTCs at their current locations and increasing deployment training, creating consolidation plans that can be accomplished just prior to deployment, or physically consolidating the UTCs. Because the first two solutions do not limit the number of deployment points of contact, this study evaluates different consolidation options based on benefits, costs, mission impact, and risks.

Consolidation has many intrinsic benefits. It reduces the number of deployment points of contact, generates economies of scale and scope, creates greater deferred procurement opportunities, improves quality control, and aggregates UTCs, which is critical when operating with limited aircraft availability.[4]

We calculated the one-time cost to transport the UTCs, warehouse rental costs, contractor salary differential, and military construction costs (Table 1). After much discussion about training, we found that the current training methodology can support the increase in the number of persons needing training at one of the three training facilities.

The following are two mission impacts of consolidation: EMEDS and aeromedical evacuation capability would be built, stored, maintained, reported, sourced, and deployed from one or just a few locations, and the fewer locations would ship that capability through fewer APOEs.

Consolidation creates large concentrations of CONUS EMEDS and aeromedical evacuation UTCs that could represent a significant loss of medical capability if made unavailable (for example, natural disaster, fire, and terrorist attack). However, two full EMEDS +25 sets are stored separately to support homeland defense, and a large portion of EMEDS capability is prepositioned overseas. There is a risk that consolidation alone will not provide the expected benefits if it becomes necessary to deploy small chunks of capability over an extended period of time. Deploying medical capability piecemeal could necessitate the use of a large number of APOEs.

This study concludes that EMEDS and aeromedical evacuation can be consolidated to better facilitate deployment operations, Air Force Manpower Standard 5530, *Medical Logistics,* should be revised, the effects of consolidation would have a minimal impact on the current training methodology, and readiness reporting should be assigned to the organization with the physical custody of the materiel.

This study recommends that the Air Force Medical Service consolidate EMEDS and aeromedical evacuation UTCs at KellyUSA, the Air Force Medical Service (AFMS) should request that Air Force Manpower Standard 5530 be recomputed for the management of medical WRM, and the Air Force Medical Service should task AFMLO to report readiness on EMEDS UTCs located at KellyUSA.

Consolidating all the 31 EMEDS and aeromedical evacuation UTCs at a single site increases the possibility of getting dedicated airlift, which helps ensure the medical capability is attained at the right place, at the right time. Even after deducting the cost of the warehouse, using the capacity already available at Kelly saves the AFMS $298K annually. While there still may be multiple APOEs, especially with smaller deployments, having one unit and one origin for all these UTCs makes the process of sourcing and tasking more straightforward. Another benefit is that reducing the number of points of contact enhances intransit visibility (ITV).

Consolidation of both EMEDS and aeromedical evacuation increases quality control of the UTCs by having a small cadre of personnel whose primary job is to manage these UTCs on a day-to-day basis. Each option may lend itself to other savings such as deferred procurement of shelf-life items. The focused efforts of a small number of personnel managing the buildup, storage, maintenance, readiness reporting, and deployment of this medical capability will lead to economies of scale and scope savings.

Ultimately, the question is whether consolidation will solve the deployment problems experienced by the AFMS during Enduring Freedom and Iraqi Freedom. While consolidation goes a long way to improve the management, sourcing, and ITV of aeromedical evacuation and EMEDS UTCs, it is not a deployment panacea. The Air Force still faces an airlift shortfall and, ultimately, the prioritization of cargo and the availability of airlift drive cargo movement.

	AE and EMEDS to AFMLO/FOW	AE and EMEDS to the East/West Coasts		AE to the East/West Coasts and EMEDS to AFMLO/FOW		AE to AMC Bases and EMEDS to AFMLO/FOW
Transportation	$170,000	$143,000		$170,000		$143,000
Construction	-	8,200,000	$10,200,000	3,300,000	4,200,000	-
Rental	$296,800	$458,000	$511,200	$469,550	$488,500	$296,800
Contractor Differential	-$595,063	$386,900	$746,149	-$284,741	-$277,741	-$322,685

Table 1. Option Costs

Notes

1. Lt Gen George Peach Taylor, Air Force Surgeon General, memorandum to Lt Gen Michael E. Zettler, Deputy Chief of Staff for Installations and Logistics, subject: Request for AFLMA Study of the Establishment of Central WRM Storage and Deployment Centers for Medical Assemblages, 4 Apr 03.
2. *Ibid.*
3. John W. Creswell, *Research Design: Qualitative & Quantitative Approaches*, Thousand Oaks, California: Sage Publications, 1994, 2.
4. Chairman of the Joint Chiefs of Staff Manual 3122.02B, *Joint Operation Planning and Execution System*, Vol III, 25 May 01, H-A-9.

Captain Overstreet is Chief, Mobility and Plans, Readiness Division, Air Force Logistics Management Agency, Maxwell AFB, Alabama.

Using the Airfield Simulation Tool for Airfield Capacity-Capability Assessment

Lieutenant Colnel Stephen M. Swartz, PhD, USAF, Retired
Captain Glen Mingee, USAF

Introduction

The Airfield Simulation Tool (AST) traditionally has been used for fleet-level analysis of transportation network flows.[1] For example, recent research completed by Captain Chris Randall at the Air Force Institute of Technology (AFIT) was used to assist the Air Mobility Command (AMC) Directorate of Logistics in assessing the impact of proposed operations on the health of the fleet. To improve this process, the directorate initiated the development of a mobility aircraft availability forecast simulation model to identify alternatives and associated impacts on aircraft availability, manpower, and cost. Randall's research identified and demonstrated how different base-support factors impact the availability of AMC aircraft. Simulation models were developed using the AST. However, the AST can be used for specific, wing-level analyses. This application is potentially quite useful for unit-level maintenance and operations managers in addressing capacity issues. The AST is a powerful tool for solving complex problems over a wide range of situations and is *user friendly* enough for many people to use effectively with a reasonable amount of training and practice.

This article presents the findings of an analysis performed by AFIT for a local logistics group commander more than a year ago. While the specifics of the analysis may no longer be timely (updates provided where relevant), this report represents the level and type of analysis that could be performed at any time by base personnel at units in similar situations. The purpose of this article is to describe the application of an available, relatively easy-to-use tool to assist logistics planners in performing analyses of airfield capacity and capability in order to achieve validation of new or existing missions and predict the ability of the base to process varying levels of workload.

With 24-hour tower operations and an abundance of available ramp space, Wright-Patterson AFB, Ohio, has opportunities for increased benefits from an optimized mix of airfield operations. In the spring of 2002, the 88th Logistics Group Commander wanted to explore the mix of existing operations with respect to proficiency training and contingency skills for his people. Without the right mix of operations, Wright-Patterson people could lose their warrior skill proficiency. This could be of special concern should Wright-Patterson be activated as an aerial port of embarkation (APOE) or be tasked to provide personnel or operational support for contingency and deployment operations. The 88th Log Group Commander solicited assistance from AFIT to determine his airfield's current capacity and capabilities in order to rationally seek the best potential increased workloads for the base. New business could provide 88th logistics personnel with valuable training and experience to ensure they are ready for APOE activation, while potentially alleviating congested aerial ports across the Air Force.

To determine Wright-Patterson's current capacity, AFIT employed the AST of the US Transportation Command's (TRANSCOM) aerial port of debarkation (APOD) model. Several modifications and adaptations were made to allow the model to be used for this project's intent. Though this report focuses on the capacity of Wright-Patterson's freight operations, preliminary research was conducted on ways to increase the proficiency of air traffic controllers. This research successfully demonstrated the efficacy of the AST for assessing airfield capacity and capability. In addition, the research identified areas where underutilized capacity could be exploited to provide additional training and proficiency opportunities. The information contained in the final report could be used to help determine what, if any, new business should be solicited for Wright-Patterson's airfield. Examples of such additional new business would include any Air Force or Department of Defense air cargo workload that could be transited through the Wright-Patterson port or any air traffic that could be routed through the Wright-Patterson airspace (to include instrument approaches or landings). Any proposed new business over that of the maximum revealed capacity could be simulated with the AST to assess further risks and probability of failure before proceeding.

Background

Wright-Patterson has undergone significant changes in operational mix since the departure of the LogAir hub in the 1990s. Tower traffic was decreased most recently with the departure of the 178th Fighter Squadron (Ohio Air National Guard F-16 unit) in April 2002. Wright-Patterson is home station to the 445th Airlift Wing (Air Force Reserve Command) and 47th Airlift Flight, comprising 18 C-141s and 6 C-21s.[2] Air traffic controllers currently experience low traffic counts, averaging only 100 per day,[3] and cargo freight personnel average only 2 air missions per week at 12 tons per mission.[4] Because of this limited peacetime traffic, the 88th Log Group Commander is concerned about personnel staying proficient in their warrior skills.[5] This concern is heightened further because of Wright-Patterson's role as an alternate APOE.

The intent of the research was to achieve two related objectives: first, perform a capacity analysis for the airfield and, second, evaluate the use of the AST as a tool for performing analyses of this type. This research comprised the first stage of a longer process to improve the efficiency, utility, and proficiency of Wright-Patterson resources. The first phase would determine Wright-Patterson's excess capacity and resource capability. The objective of this phase was to map the feasible region of resource capabilities with respect to a variety of operational loads. This would give the 88th Log Group Commander a measure of confidence prior to entering the second phase of the project. The second phase would take the resulting data and use it to help solicit new business for the airfield in an effort to better utilize personnel and resources. This endeavor has the potential to be of mutual benefit to both the 88th Log Group Commander and the Air Force. While new business would serve to improve both the peacetime and wartime skill proficiency of the 88th Log Group personnel, it could help alleviate loads on aerial ports at other installations. The results of the first phase carry over into the second, as the potential additional workload must be analyzed from a capacity feasibility standpoint to prevent overloading of critically constrained resources.

Methodology

The first phase of the project started with onsite interviews with subject-matter experts in affected areas and a review of past empirical data. Interviews and data both confirmed a suboptimization of existing capacity. For example, the performance of work statement from the existing freight contract yielded the following annual workload comparison (adjusted for spike activity) for gross air cargo (tons): 1,321 planned versus 974 actual, for a 73-percent utilization rate.[6]

To conduct the most accurate capability assessment possible, research was conducted to find a viable tool to model Wright-Patterson's current activity. The AST of the USTRANSCOM APOD model eventually was chosen. An assessment of AST is included in the section of results in this article. AST's viability in this type of project, along with limitations and associated recommendations, are provided.

Existing resources and a typical day's workload were modeled in an AST scenario. Home-station aircraft missions were simulated via a formatted file input. Transient aircraft were simulated via an AST-conducted random generation of aircraft, closely approximating historical airframe mixes as closely as possible. A 30-day simulation was then run for ten different iterations to determine the effect on the airfield. Although Wright-Patterson's weekend activity does not mirror that of its workweek, a 5-day simulation would not have yielded sufficient variability. AST does not account for weekends as it is primarily a mobility-planning tool and, thus, had to be adapted for this project's use. Running simulations for 30 straight days provided more variability and gave a better representation of the strain put on airfield resources caused by increased air traffic. A complete list of AST modeling assumptions particular to this project can be obtained by contacting the authors.

The first simulation was conducted to validate AST against Wright-Patterson's current activity. The model was validated using historical data, and AST reflected Wright-Patterson's ability to meet its current workload without any late aircraft departures because of constraints on airfield resources. These results were expected because of the low aircraft traffic experienced at Wright-Patterson. AST classifies a late aircraft as anything departing more than 15 minutes past its scheduled takeoff time. Scheduled takeoff times are based on standard ground times listed in Air Force Pamphlet (AFPAM) 10-1403.

Subsequent simulations then were conducted to determine the maximum cargo throughput of Wright-Patterson's airfield. C-5 cargo missions were incrementally added (with random arrival rates) until a predetermined (considered intolerable by the log group commander) number of late aircraft departures began. At that point, subsequent simulations were conducted with different combinations of resources to determine the exact cause of late departures in order to identify the airfield's limiting factors. For example, the option to simulate materiel-handling equipment (MHE) and refueling truck breakdowns was turned on or off, and the amount of MHE and number of refueling trucks on hand were increased or decreased. Analyzing the effects of these mixes helped determine if the limiting factor was the actual amount of equipment on hand or the maintenance downtime associated with the airfield's heavier use.

Simulations were conducted for landing aircraft and unloading munitions at Wright-Patterson's hot cargo pads (HCP). This was done to plan for the possibility of only being able to obtain munitions missions as new business to the airfield. The hot cargo pads are twice the travel time from the cargo yard as the normal cargo plane parking area on the east ramp. Consequently, it was assumed that these missions would cause more late takeoffs because of the increased processing time, equipment operating hours, and associated maintenance downtime.

Once the maximum throughput of cargo *tonnage* was determined, subsequent simulations were conducted to determine the maximum cargo *aircraft* throughput for Wright-Patterson. Maximum C-5 planning loads (60 tons) were translated into equivalently loaded C-17s, C-141s, and C-130s.[7] This enabled the 88th Log Group Commander to know if increased cargo plane traffic would have a detrimental effect on other areas of his airfield besides freight operations; for example, refueling or maintenance operations.

Upon completion of the simulations, results were reviewed at weekly staff meetings, and the 88th Log Group Commander approved the closure of Phase I. The 88th Logistics Group subject-matter experts from freight and fuels operations validated the results. At that point, the Logistics Group began the search-and-analysis process for securing additional workloads for training and proficiency.

Results of Capacity Analysis

A spreadsheet summary of all 28 completed simulations can be obtained by contacting the authors; representative summary results are included here. With current resources (two K-loaders, six refueling trucks, and three hydrant-servicing vehicles), AST revealed Wright-Patterson's maximum cargo throughput to be 60 tons for both munitions and nonmunitions loads, compliant with current 445th Airlift Wing, 47th Airlift Flight, and 178th Fighter Squadron activity levels. Overall results are described in two main findings below.

- **Sixty Tons (Nonmunitions), Each Duty Day, Offloaded at the East Ramp (Standard Parking Area) Hydrant Outlet Parking Spots**. These 60 tons can be delivered in any aircraft configuration (that is, one C-5, two C-17s, three C-141s, or five C-130s). Though resources were deemed sufficient to handle this increased workload, it would not come without some risk. AST revealed that 6.6 percent of simulated cargo aircraft missions were late because of K-loader unavailability, with 3 percent delayed for more than 8 hours (215 of 3,300). For R-11 refueling trucks, AST revealed that 0.2 percent of simulated aircraft missions were late because of truck unavailability (88 of 43,975). Finally, unavailability of hydrant-servicing vehicles caused 0.4 percent of all hydrant-serviced simulated aircraft missions to be late (5 of 1,230).

- **Sixty Tons (Munitions), Every Other Day, Offloaded at the Hot Cargo Pad.** These 60 tons also can be delivered in any aircraft configuration. For these missions, the risk increases. AST revealed that 25 percent of simulated cargo aircraft were late because of K-loader unavailability (415 of 1,650), with 4.4 percent delayed more than 8 hours. For R-11 refueling trucks, AST revealed that 2 percent of simulated aircraft were late because of truck unavailability (869 of 43,038).

The increase in late aircraft missions because of K-loader unavailability seems dramatic at first, rising from 6.6 percent to 25 percent. However, the extreme delays caused by both K-loaders breaking (the biggest concern) remain fairly constant (4.4 percent versus 3 percent of late missions). The increase in the number of shorter delays is caused when only one of the two K-loaders is available with the extra time required to travel the longer distance from the cargo yard to the hot cargo pad (versus the east ramp standard parking area).

The increase in late aircraft missions because of R-11 refueling trucks seems dramatic at first look, rising from 0.2 percent to 2 percent. However, this increase rises exponentially as the cargo aircraft flowthrough escalates from one C-5 to five C-130s each day. These delays are nearly always 1 hour or less, so the impact is not necessarily unacceptable.

To help prevent late aircraft, Wright-Patterson maintenance practices should be evaluated to ensure equipment availability. As a possible suggestion, maintenance shifts could be added on weekends to prepare MHE and refueling trucks for use on the following Mondays. Since all AST simulations were run for 30 straight days, no equipment recovery time on weekends was factored in. Because of this adaptation, the number of late aircraft should be less under a real-world, 5-day-a-week scenario with weekend duty for maintenance people. In addition, for late departures, the true definition of late must be determined for each type of mission solicited. Aircraft will not always be required to depart within standard ground times listed in AFPAM 10-1403. If ground times could be relaxed, these occurrences would decrease substantially.

Operational Risk Management

Increasing airfield business does not pose a risk solely in terms of late aircraft departures. A complete operational risk management assessment can be obtained from the authors. The major areas of concern are highlighted below:

- **Cargo Processing and Dock Clearance Speed.** The ability to build up pallets and clear the dock and cargo yard must be evaluated to ensure the airfield is ready for subsequent cargo missions. The ability to complete associated paperwork and required computer data entries, availability of adequate warehouse space, and pallet and net supplies also must be taken into account. As AST is an APOD tool, it does not model these areas.
- **HCP Location**. Certain mixes of munitions cargo would force the temporary closure of the golf course's driving range during offloading operations.[8] This could cause a substantial loss in funds for morale, welfare, and recreation. Other sites should be evaluated as possible alternate offloading areas for munitions. Note that this limitation represents a *peacetime only* consideration.
- **Wright-Patterson Alternate APOE Designation**. Any new business brought to Wright-Patterson could be interrupted for long periods of time during contingencies. Any new missions taken on by the base potentially would be of a lower priority to the contingency missions already tasked.
- **Existing Freight Contract**. According to the contract's performance of work statement, AST-calculated maximum throughput quantities would be 1,180 percent more than the planned workload for everyday missions and 708 percent more than for every-other-day HCP missions.[9] The effect on contract costs must be determined to make a cost-benefit analysis.
- **Startup Effect.** The long period of underutilization at Wright-Patterson could cause sluggish initial performance if workloads increase.

Additional Workload

Although this report focuses on Wright-Patterson's capacity for expanded cargo missions, preliminary research was conducted on ways to increase skill proficiencies of the base's air traffic controllers. Wright-Patterson temporarily hosted the 178th when its operations were moved from Buckley Field in Columbus, Ohio. The increased traffic counts resulting from the temporary relocation of the 178th were extremely beneficial to Wright-Patterson controllers. The departure of the 178th in April 2002 eventually could decrease the skill proficiency of air traffic controllers, and opportunities to bring new business to the airfield will be explored by the 88th Log Group to counter any negative effects.[10] AST simulations reveal that Wright-Patterson could double the amount of fighter traffic it currently experiences.

The addition of a global positioning satellite (GPS) approach at Wright-Patterson is one possibility for increasing air traffic counts. It is estimated that less than 20 percent of all military installations possess GPS approaches.[11] It is likely that such an approach at Wright-Patterson could entice numerous training missions to the airfield for pilots to certify and recertify on those types of approaches.

The last area for exploitation is the Tower Simulation System (TSS) currently under development. The 360-degree simulator provides an excellent, life-like training environment that can simulate any condition at any airfield.[12] The addition of this simulator at Wright-Patterson could be extremely beneficial, as it would provide a low-risk training environment for initial and refresher controller training. The simulator could be invaluable because of Wright-Patterson's low traffic count, providing life-like training in the absence of real-world missions to the airfield.

The TSS is required to be ready for training on 30 September 2002. Wright-Patterson is ranked fifth out of six bases on the Air Force Materiel Command (AFMC) priority list to receive the TSS. The low ranking is caused by the higher number of trainees and traffic counts at other installations. Only two to four simulators will be bought in fiscal year (FY), and 20-30 will be requested for FY03. With 94 sites eventually receiving the TSS, Wright-Patterson would have to wait a long time at the present ranking.[13] A joint effort between AFIT and the 88th Log Group could possibly raise Wright-Patterson's receipt priority. AFIT could provide justification that the close proximity of their engineering experts would assist greatly in TSS beta testing. The 88th could justify that maintaining proficiency at lower traffic-count bases is just as important as, if not more than, training new recruits at bases with higher traffic counts. The rationale would be that higher traffic counts naturally lend to faster training and better maintenance of air traffic controller proficiency and, therefore, the TSS would be needed more at bases with low traffic counts.

Results of AST Analysis

To determine Wright-Patterson's airfield capacity, AFIT used the AST, a subcomponent of the TRANSCOM APOD model. As such, it is designed to evaluate an APOD's ability to meet its contingency flowthrough tasking. This presented some difficulty in adapting the model for day-to-day, noncontingency use. Another limitation of AST is, since it is an APOD tool, there is no way to assess an airfield's ability to prepare outgoing cargo in time to meet scheduled aircraft departures.

Cooperation between AFIT and TRANSCOM-affiliated personnel made the completion of this project possible. The assistance of Lieutenant Colonel Robert Brigantic, Jean Mahan, and Dr Travis Cusick were invaluable in completing this research effort. Their cooperation extended to a staff assistance visit conducted on 13 February 2002, and continuous interaction resulted in several improvements and modifications to the AST software. These improvements made the model easier to use and the simulation results easier to analyze.

User analysis of simulation results reveals AST to be a viable tool to assess airfield capacity. To validate this assessment, a working maximum-on-ground (MOG) calculation was requested through AFMC personnel. The purpose of requesting a working MOG calculation is to compare it to baseline results of the AST simulations, thereby serving to validate its viability.

Before listing recommended improvements to the AST, it must be recognized that the AST was not designed for performing this type of analysis. Though AST was able to be adapted for this project's intent, several features could be developed to make it easier to use for nonmobility or APOE purposes. The following is a list of findings and recommendations to improve the use of the AST for similar projects in the future. Areas of concern include model Fidelity, Execution, and Interpretation.

Fidelity

- **Observation 1**. Since AST is not designed for peacetime operations, weekends cannot be accounted for during random generation of aircraft. This can be remedied for most missions by generating aircraft via formatted files. However, this was not possible for transient aircraft. AST assumes a constant availability rate for all airfield resources, 24 hours a day. This made it difficult to model a normal 8-hour workday. To generate transient aircraft arrivals randomly, AST takes a desired number of arrivals (determined by the user) and uses a mean time between arrival formula. These arrivals occur at a normal rate of distribution throughout the 24-hour period. AST has no way to condense a desired daily number to enable the majority of arrivals to fit into normal operating hours. Although Wright-Patterson is open 24 hours, airfield operating hours were set at 0745-1630 to coincide with the availability of all airfield resources. Since subject-matter experts stated the majority of transient aircraft land during normal duty hours, random generation of transient aircraft was set to land the approximate historical transient aircraft per day within the 8.75-hour period. Generating transient aircraft via a formatted file input would have been too labor intensive and too hard to change for subsequent simulations. This possibly overworked simulated resources during normal duty hours, potentially inflating late departure occurrences. This also prevented the ability to evaluate after-hours support or take this level of capacity into consideration.
- **Observation 2**. Since AST is part of the APOD model, APOE peculiarities are not modeled. For example, cargo for onload operations is assumed to be wrapped and strapped, with all associated paperwork and computer entries completed. No delays are built into the model to account for these actions. This is not practical in real-world scenarios, as numerous problems could prevent cargo from being ready to ship. This artifact will result in project owners having to assess their ability to prepare cargo independently in time to meet scheduled aircraft departures. It is recommended that an APOE version of the AST be developed, reversing Army Enabler duties; include an option for the percentage of cargo ready to move versus that cargo which requires processing actions; and include a delay time for those that do.
- **Observation 3**. Formatted file inputs do not have a column to designate flights as hazardous cargo missions. A user can designate all of an aircraft type to park only at a hot cargo pad as a remedy. However, this presents a problem if not all aircraft in the mission design series will be required to carry hazardous cargo. This produces an inability to evaluate mixes of hazardous and nonhazardous cargo flights by the same mission design series. The user must use other mission design series as substitutes for desired mission design series, leading to possible confusion and error when analyzing simulation results. This could be addressed through the creation of an ability to specify each formatted file aircraft as either a hazardous or nonhazardous mission. However, a workaround exists in that, when the simulation of hazardous cargo is enabled in AST, the aircraft generated from flat files follow the same hazardous percentages found in the aircraft and details window that internally generated aircraft follow. Therefore, by aircraft type, the user can specify the probability that any individual aircraft will contain hazardous material.
- **Observation 4**. Since AST is part of the APOD model, it is most concerned with the simulation of cargo aircraft. As such, it does not model fighter aircraft. Though the user has the ability to model customized aircraft to simulate fighter traffic, this drawback posed a problem in the area of refueling. AST assumes that all trucks are full of fuel as they wait to service their next aircraft. This means that they go back to the fill stand to refuel after every aircraft servicing. This creates unnecessary travel when refueling fighter aircraft, as one full R-11 can service three to five F-16s before needing to return to the fill stand. This resulted in the modeling of unnecessary travel back to fill stands by R-11 trucks, causing delays in servicing and the potential for late aircraft departures. Though this can give a measure of confidence that simulation results with no late departures can be relied on, a true capacity is impossible to measure. The user also had to calculate the number of unnecessary trips back to the fill stand to compensate for the increased usage hours. The mean time between failure rates for R-11 trucks was adjusted accordingly. Since AST models K-loaders to go immediately to the next aircraft in need, perhaps the same could be done for petroleum, oil, and lubricant trucks. A refill level for the R-11 could be established and a decision point implemented on whether or not to send a truck to the next aircraft requiring service or back to the fill stand for refueling.

Execution

- **Observation 5**. Airfield and aircraft random number seeds must be set manually during multiple iterations. Subsequent iterations begin incrementally from that seed number (for example, ten iterations starting at seed number 20 continue with seed numbers 21, 22, 23, 24...29). With 1,000 seed numbers for each field, this seems to limit the range of reported variance. AST could be enabled to proceed with multiple iterations through random seed number assignments versus incrementally from a manually set seed. In addition, some seed numbers crash the simulations while others work fine. Multiple iterations were set to only ten because of wasted time when crashing after trying higher numbers. Both of these problems required manual workarounds and resulted in significant nonvalue-added time on the part of the user. If the synchronization of random number streams is not an issue (when predicting the utility of a single model, for example, vice comparing alternative configurations), this is not necessary.

- **Observation 6**. Users must input standard ground times. It may be helpful if the model could calculate this automatically based on fuel and cargo load plans. This would prevent the user from having to change the standard ground time for random aircraft generation or departure times in formatted file aircraft generation. Simply setting all standard ground times to zero would result in aircraft leaving as soon as their processes are complete; however, this results in all aircraft reflecting as late in output result files. Changing departure times in formatted files for added cargo aircraft in subsequent simulations was tedious and time-consuming. The creation of an option to allow for automatic calculation on standard ground times based on fuel and cargo loads would solve this issue.

Interpretation

- **Observation 7**. The actual root cause for late aircraft departures is sometimes hard to determine. In the Summary.Out files, the total number of late aircraft is given (*Break* or *No Break*) with no breakdown of reasons. Aircraft can have delay times in more than one category, and reference to several of the output files is required to narrow down the exact reasons for late aircraft. In some instances, the best and only way to ascertain the root cause is to change the airfield parameters and run subsequent simulations to determine if the late occurrences still occur. This caused an occasional exorbitant amount of time analyzing results to determine reasons for late aircraft departures. If there was a way to categorize root reasons for late aircraft and reporting total numbers by cause in Summary.Out files, it would speed interpretation and analysis greatly. This observation actually resulted in several AST modifications made by the contractor. The addition of two aircraft delay categories in ACDATA.Out files was most helpful (delay for refueling truck and delay for hydrant). In addition, Summary.Out files list average delay times for different categories. However, this average is applied to all aircraft, not just late departing aircraft. This quick snapshot underestimates the effect of delays in these areas, as a very small average actually can comprise numerous lengthy delays. Categorize root reasons for late aircraft and report total numbers by cause in Summary.Out files. If keeping total average delay categories, that average must be calculated from late aircraft only.

Overall, the AST was used successfully to model peacetime operations at Wright-Patterson. While there are several improvements that could be made to ease the use of the software, the model generated valid, useful results. The analysis of logistics capacity and capabilities of an aerial port (either *peacetime* or *wartime*) provides extremely valuable information to Air Force leadership.

Conclusions and Recommendations

The AST, although primarily used for mobility planning, is a valid assessment tool to measure baseline airfield capacity. By changing input parameters in successive simulations, certain effects could be predicted and modeled. Several difficulties encountered during this analysis were addressed and resolved by the model development team at USTRANSCOM. Model performance and ease of use improved greatly during the short period of this study and is expected to improve even more. Based on these results and their corresponding analyses, it is believed AST provided an accurate account of Wright-Patterson's capability to handle the increased workloads outlined in the simulation parameters. This result could be applied to any airfield and would provide valuable information about logistics capacity.

Wright-Patterson undoubtedly can handle increased air traffic, either through additional cargo missions or smaller aircraft. An appropriate mix of cargo and tactical aircraft would be desired to ensure proficiency in both areas of freight and tower operations. During the logistics buildup in preparation for and support of Operation Iraqi Freedom, Wright-Patterson was tasked to provide en route port services in support of multiple deployment taskings. Information derived as a result of this analysis was very helpful to Wright-Patterson in supporting these operations.[14] Decisions were implemented with respect to improving capacity (explosive safety zones redesign, scheduling, resource allocation, and so forth) rapidly and smoothly, and the effects of changes to operations were predictable and relevant.

In the event new business is unobtainable, alternatives must be explored to increase training opportunities and ensure warrior skill proficiency. In addition to obtaining a new GPS approach and the TSS, inhouse training scenarios and exercises could be developed in more detail, with more realism and increased frequency and duration. Mockup cargo pallets could be constructed and loaded onto C-141 schoolhouse aircraft, with computer data inputs loaded into dummy global transportation network databases.

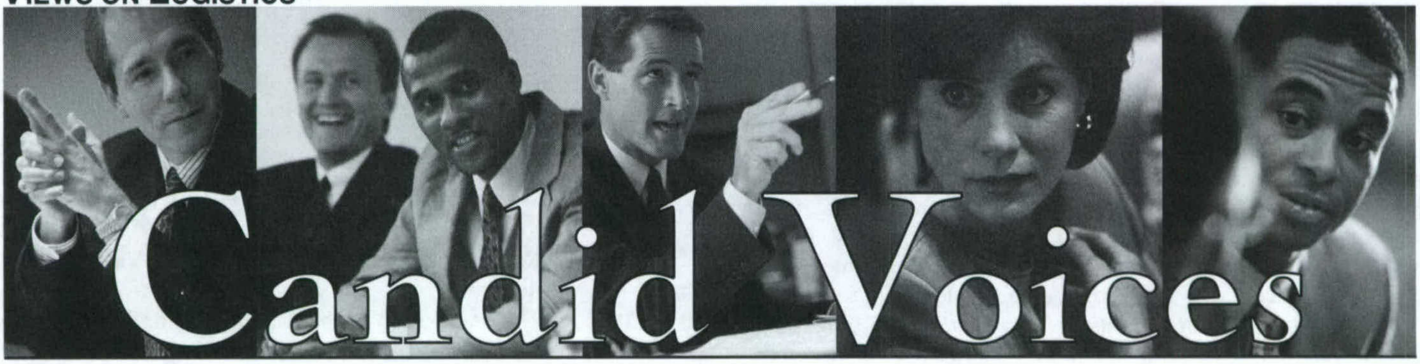
The 88th Log Group should proceed to solicit new business for Wright-Patterson's airfield. New business should be undertaken incrementally and with caution. Careful attention should be given to the risks outlined in the operational risk management assessment. Any new business scenario should be modeled using the AST and simulated at least at 100 iterations to determine possible effects on airfield resources.

Finally, USTRANSCOM should consider implementing some or all the recommendations presented in the AST evaluation phase of this investigation. Although AST was successfully adapted for nonmobility and APOE use, recommended changes could result in a new AST version designed exclusively for those purposes. The ability to model aerial port operations at this level of detail and accuracy could provide a core competitive advantage in managing these complex operations.

Notes

1. Capt Christian E. Randall, An Analysis of the Impact of Base Support Resources on the Availability of Air Mobility Command Aircraft, MS Thesis, AFIT, Wright-Patterson AFB, Ohio, Mar 04 (AFIT/GLM/ENS/04-15).
2. Author's e-mail interviews with Col James Blackman, 445th Operations Group, Wright-Patterson AFB, Ohio, 27 Feb 02, and Lt Col Richard Baker, 47th Airlift Flight, Wright-Patterson AFB, Ohio, 17 Apr 02.

(continued on page 45)



What DoD Logisticians Should Know About the Army

James C. Bates, Lieutenant Colonel, USA, Retired

Introduction

As US military operations become increasingly joint and with the increased involvement of government interagency activities and coalition partners, it is beneficial for Department of Defense (DoD) logisticians, both military and civilian, to have a basic understanding of the organizational structure and logistics-related aspects of all the Services, not just the service they are assigned to. This article's focus is the Army. It is the fourth in a series; the previous articles were published in *The Army Logistician* and were aptly named "What Army Logisticians Should Know about the Air Force" (September-October 2003), "What Army Logisticians Should Know About the Navy" (November-December 2003), and "What Army Logisticians Should Know About the Marine Corps" (July-August 2003). All are online and available at http://www.almc.army.mil/alog/index.asp.

Sustaining Deployed Army Forces

The Army is America's senior service, having been founded in 1775. It also has the most members of any of the Services. From a logistics perspective, it has unique characteristics that offer certain challenges not faced by the other services. For instance, unlike Navy, Air Force, and Marine amphibious forces, the Army depends entirely on the other services or the civilian sector for strategic transportation lift. Moreover, as the primary land force, Army forces disperse over a wide area and in remote locations. This compounds the difficulties involved in supply chain management since—in such a distributed, noncontiguous environment—there are multiple transportation stops, potential mode changes (air to land, rail to road, sea to air, sea to land, and so on), and transload configuration changes (individual items being moved from 40-foot containers into 20-foot containers, 463L pallets to palletized load system trucks, multipack boxes to parts bins, and so on). Moreover, the software, hardware, telecommunications devices, computers, and automatic identification technology needed for an effective logistics management information network must be linked over extended distances and in austere environments. Thousands of information input sites are distributed over vast noncontiguous environments. Frankly, providing cost-effective, responsive, and visible sustainment to such a force is a formidable task.

For instance, for a logistics information network to be able to track the quantity of a specific truck tire available within an area of operations like Iraq, all the onhand visibility data associated with this type of tire somehow must be transmitted to the network servers on at least a daily basis, preferably twice daily. This means every unit and support battalion within the area of operations—there could be more than a thousand units and tens of support units—that have or need the tire must transmit this information to a centralized data repository. However, unlike a ship or an established Air Force base, Army units forwardly deployed do not have telecommunications land lines or habitual satellite links. Providing logistics support and obtaining reliable logistics information in this type of environment, especially when forces are frequently relocating, is indeed a Herculean task. With this in mind, let us take a look at how the Army is structured and then review the transformational changes underway or planned.

The Total Army

According to the Army almanacs of 2002 and 2003, the active Army force has 485,000 soldiers and about 200,000 Department of the Army civilians. In addition, the Army Reserve has 206,000 soldiers, and the Army National Guard has 352,000 soldiers. The Army Reserve is controlled completely by the Federal Government and serves solely as a Federal reserve to the active Army. The Army National Guard, on the other hand, may be controlled by either the state or the Federal Government, depending on the circumstance. The Army Guard force structure consists of combat, combat support, and combat service support units, while the Army Reserve force is comprised primarily of combat support and combat service support. Both organizations are part of the Army, which consists of the Active, Guard, and Reserve components.

Rank and Pay Grade

The following are the ranks and corresponding pay grades within the Army, from lowest to highest. E stands for enlisted, WO stands for warrant officer, and O stands for officer. Trainee (E-1), private (E-2), private first class (E-3), corporal (E-4), sergeant (E-5), staff sergeant (E-6), sergeant first class (E-7), master sergeant (E-8), first sergeant (E-8 serving as top enlisted soldier in a company), sergeant major (E-9), command sergeant major (E-9 serving as the senior enlisted soldier in a battalion or higher), WO1, WO2, WO3, WO4, WO5, second lieutenant (O-1), first lieutenant (O-2), captain (O-3), major (O-4), lieutenant colonel (O-5), colonel (O-6), brigadier general (O-7), major general (O-8), lieutenant general (O-9), and general (O-10).

Army Organization

From smallest to largest, the Army is organized as follows: soldier, team, squad, platoon, company (also called troop by cavalry forces or battery by artillery forces), battalion (also called squadron by cavalry forces), brigade (also called group by logistics forces or regiment by special forces), division, corps, and army service component command (ASCC). Colloquially known as *The Ultimate Weapon*, the soldier is the foundation of the Army. Five soldiers make up a team, and two teams make up a squad. A squad is considered the smallest element within the Army. It typically has 9-11 soldiers and is led by a sergeant or staff sergeant. Two or more squads make up a platoon, which usually has about 40 soldiers and is led by a lieutenant. Two to four platoons make up a company, which is commanded by a captain and contains from 62 to 200 soldiers. Currently, companies are the smallest Army element to be routinely assigned unit identification codes and DoD Activity Address Codes. Four to six companies make up a battalion, which is commanded by a lieutenant colonel and has from 300 to 1,000 soldiers. Two to five battalions make up a brigade, which is commanded by a colonel and has from 3,000 to 5,000 soldiers. Three or more brigades typically make up a division, which is commanded by a major general and has from 10,000 to 17,000 soldiers. Two or more divisions make up a corps, which is commanded by a lieutenant general and has from 20,000 to 45,000 soldiers. The Army's largest suborganization is the ASCC. It typically has 50,000 plus soldiers, is made up of two or more corps, and is commanded by a lieutenant general or a general.

There are ten active-duty divisions in the Army: the 1st Armored Division and the 1st Infantry Division (Mechanized) home stationed in Germany; 2d Infantry Division home stationed in Korea; 25th Infantry Division home stationed in Hawaii; 10th Mountain Division home stationed at Fort Drum, New York; 82d Airborne Division home stationed at Fort Bragg, North Carolina; the 101st Air Assault Division home stationed at Fort Campbell, Kentucky; the 1st Cavalry Division and the 4th Infantry Division (Mechanized) home stationed at Fort Hood; and 3d Infantry Division (Mechanized) home stationed at Fort Stewart, Georgia. Armored divisions and mechanized infantry divisions use armored vehicles (primarily M1 tanks, M2/3 Bradley fighting vehicles, and M113 armored personnel carriers). Both divisions have all three of these weapon systems, though armored divisions have more tanks than do mechanized infantry divisions.

There are four active corps headquarters: the 5th Corps, which oversees the 1st Armored and 1st Infantry Divisions in Germany; 3d Corps, which oversees the 1st Cavalry and 4th Infantry Divisions at Fort Hood; 1st Corps, which oversees the 25th Infantry Division and 2d Infantry Division; and 18th Airborne Corps, which oversees the 82d Airborne Division, 10th Mountain Division, 101st Airborne Division, and 3d Infantry Division (Mechanized).

There are five ASCCs. These theater-level commands include the US Army Europe headquartered in Germany, covering the US European Command area of responsibility; US Army Pacific, headquartered in Japan, covering the US Pacific Command area of responsibility; US Army South, headquartered in Texas, covering the US Southern Command's area of responsibility; Third Army, headquartered in Georgia, covering US Central Command's area of responsibility; and Eighth Army, headquartered in Korea.

Major Subordinate Commands

In addition to the five ASCCs just described, the Department of Army has the following major subordinate commands: the Forces Command (FORSCOM), Army Special Operations Command, Training and Doctrine Command (TRADOC), Army Materiel Command (AMC), Army Medical Command, Surface Deployment and Distribution Command (SDDC)—formerly called the Military Traffic Management Command—US Army Intelligence and Security Command, Space and Missile Defense Command, Army Corps of Engineers, Army Criminal Investigation Command, and Army Military District Washington. Of these major subordinate commands, we will take a look at FORSCOM, TRADOC, and the SDDC. Then we will take a closer look at AMC.

Like the Air Force's Air Combat Command, the Navy's Fleet Forces Command and the Marine Corps' Marine Forces Atlantic, FORSCOM is an integral part of the Joint Forces Command and provides forces to the unified combatant commands. It is the Army's largest major subordinate command and is headquartered at Fort McPherson, Georgia. FORSCOM has more than 760,000 Active Army, Army Reserve, and Army National Guard soldiers; it trains, mobilizes, deploys, and sustains combat-ready forces capable of rapidly responding to crises worldwide.

TRADOC, like FORSCOM, is a four-star level command. It recruits, trains, and educates the soldiers; develops leaders; supports unit training; develops doctrine; establishes standards; and designs the future Army. TRADOC has three subordinate commands: the Combined Arms Center at Fort Leavenworth, Kansas; Maneuver Support Center at Fort Leonard Wood, Missouri; and Combined Arms Support Command (CASCOM) at Fort Lee, Virginia. CASCOM is the focal point for most of the Army's logistics training and doctrine development, with the notable exceptions of medical and engineer-related training. CASCOM maintains a Web site full of logistics information at http://www.cascom.army.mil/.

SDDC provides global surface deployment command and control and distribution operations. Similar to the Navy's Military Sealift Command (MSC) and the Air Force's Air Mobility Command, SDDC is an integral part of the Transportation Command. Cargo distribution and port management are its two critical missions. SDDC develops transportation contracts and container-leasing agreements and oversees the transportation management of freight containing tanks, fuel, ammunition, combat vehicles, food, and other commodities destined to locations throughout the world. In support of port management, SDDC serves as the single port manager at 25 locations worldwide and, as such, is responsible for all aspects of the ship loading and unloading process. The Transportation Engineering Agency of the SDDC—located in Newport News, Virginia—researches and publishes information about worldwide ports; how to load vessels and aircraft; and how to transport items by rail, road, air, or vessel. Its Web site is http://www.tea.army.mil/index.htm.

Army Materiel Command

Like TRADOC and the SDDC, AMC has a significant impact on operational logistics. It is comparable to the Air Force Materiel Command, Naval Supply Systems Command, and Marine Corps Materiel Command. AMC is the Army's premier provider of materiel readiness, to include technology, acquisition support, materiel development, logistics power projection, and sustainment. AMC operates the research, development, and engineering centers; Army Research Laboratory; depots; arsenals; and ammunition plants. It also maintains the Army's prepositioned stocks, both on land and afloat. AMC is headquartered at Fort Belvoir, Virginia. The total AMC workforce, both civilian and military, approaches 50,000. Its subordinate commands are as follows: the Army Field Support Command (Provisional) (AFSC); Army Aviation and Missile Command; Army Communications-Electronics Command, Army Chemicals Materials Agency (Provisional); Army Research, Development, and Engineering Command (Provisional); Army Soldier and Biological Chemical Command; Army Tank-Automotive and Armaments Command; and Army Security Assistance Command.

One of the newer AMC subordinate commands is AFSC. It oversees the Army's prepositioned stocks and is a component of the strategic mobility triad of airlift, sealift, and global prepositioning. AFSC manages the prepositioned brigade sets of materiel, operational projects, and sustainment stocks positioned either afloat or in overseas, forward-deployed locations. Army prepositioned stock (APS)-2 is stored at several combat equipment group bases in Europe. APS-3 is afloat, APS-5 is maintained in storage in Kuwait and Qatar, and APS-4 is stored in Korea. To find out more about the Army's prepositioned stocks, visit the following Web site: https://www6.osc.army.mil/fsc/mission/hqmission.asp. AFSC also manages the Logistics Civil Augmentation Program for peacetime planning, warfighter exercises, and crisis action support.

Although considered a separate reporting activity and not a subordinate command of AMC, the Logistics Support Activity (LOGSA) serves as a central repository of critical supply, maintenance, and transportation data. Over the course of the last 10 years, this organization has evolved from managing multiple logistics information systems to managing a single, Web-based system called the Logistics Integrated Database (LIDB). It is used to access LOGSA's numerous logistics databases and acquisition tools. Entry to the LIDB is via the following Web site: http://www.logsa.army.mil/pubs.htm; however, a password is required. LOGSA publishes an excellent preventive maintenance publication geared toward junior soldiers (but actually read at all levels) called *Preventive Services*, available online at http://www.logsa.army.mil/psmag/psonline.htm.

Army Equipment

Providing logistics support, especially Class IX, to all the Army units worldwide is made ever the more challenging because of the extensive diversity of the major end items (Class VII) that combat, combat support, and combat service support (CSS) units employ. Army units must maintain planes; weapon systems; helicopters; trucks; generators; signal, engineer, medical, water purification, petroleum, ammunition, and food preparation equipment; and so forth for units spread across the depth and width of the battlefield.

Some of the major combat equipment includes the M1 Abrams tank, M2/M3 Bradley fighting vehicle, the M109 self-propelled Howitzer, M113 armored personnel carrier (all of which use tracks rather than wheels), and the AH-64 Apache attack helicopter. Some of the major combat support equipment includes the M9 armored earth mover; the M104 Patriot air defense missile; the M93 Fox nuclear, biological, chemical reconnaissance vehicle; the UH-60 Black Hawk utility helicopter; and the CH-47 Chinook heavy lift helicopter. Some of the major CSS equipment includes the family of medium truck vehicles, M-977 heavy expanded mobility tactical trucks, the palletized load system trucks, and heavy equipment transporter trucks.

Strategic Lift

As mentioned previously, the Army is the only service that depends on the other services—primarily the Navy's MSC and the Air Force's Air Mobility Command—to provide all the strategic transportation needed for it to deploy overseas. There are complicated tradeoffs involved in determining the type and size of the Army force to be deployed. The heavier the force (heavy forces refer to the presence of armored vehicles—forces that have a substantial weight), the more lift is required to deploy the force, the larger the logistics footprint, and the longer the time required to reach the engagement area. Yet, the heavier the force, the less vulnerable it is once deployed, and the more firepower it has once it gets there. America's largest cargo planes, the C-5 Galaxy and C-17 Globemaster, can lift only one M1 Abrams tank at a time. The C-17 can lift up to four UH-60 Blackhawk helicopters, two AH-64 Apache attack helicopters, or three Bradley fighting vehicles. To give an idea of the magnitude of airlift required, the current armored division has more than 240 M1 tanks, more than 240 Bradley fighting vehicles, and 18 AH-64 attack helicopters, along with thousands of other vehicles, both tracked and wheeled, containers, and other equipment.

The Army's newest wheeled, yet armored, fighting vehicle, the 36,000-pound Stryker, can be transported on the ground using trucks or by air on C-5, C-17, and C-130 aircraft. The C-5 and C-17 aircraft can carry seven and four Strykers respectively.

One large medium-speed roll-on roll-off (LMSR) vessel or two fast sealift ships can lift almost an entire Stryker brigade combat team (SBCT). The LMSR and fast sealift ships have a draft of about 37 feet and a sustainable speed of about 25 knots. The MSC has 8 fast sealift ships and 20 LMSRs in its inventory.

Tactical Logistics

Once the strategic lift deploys Army forces to where they are required, tactical logistics moves to the forefront. From this perspective, there are three types of Army units: combat arms, combat support, and combat service support. The three types also are referred to as maneuver, maneuver support, and maneuver sustainment. This article stresses logistics support to combat arms units. At the unit level, the executive officer (typically a first lieutenant) oversees logistics. The executive officer is assisted by a supply sergeant and a maintenance sergeant. At the battalion level, the support, maintenance, and medical platoons of the headquarters and headquarters company provide logistics support to the battalion's organic units. At the brigade level, logistics organizations, called support battalions, provide additional logistics. Though support battalions may be made up of a wide variety of supply, maintenance, transportation, and medical companies, the typical brigade-level support battalion has a supply company (some supply companies are transitioning to distribution companies as they are fielded transportation assets), a maintenance company, and a medical company.

Forward support battalions provide support to divisional maneuver brigades. Brigade support battalions provide support to Stryker brigade combat teams. Corps support battalions (CSB) provide reinforcing logistics to maneuver brigades and primary logistics to corps units. The corps support battalions also provide *services* such as laundry, showers, water purification, airdrop, and mortuary affairs. A division's support battalions are organized within a brigade-level organization known as a divisional support command. Corps support battalions are organized within a brigade-level organization known as a corps support group. Two or more corps support groups help form a corps support command, which also has a materiel management center, a movement control battalion, and a troop support battalion.

The accounting, visibility, and control functions associated with supplies and maintenance are under the auspices of a materiel management center at both the division and corps level. The movement control office and movement control battalion perform the transportation control functions at the division and corps levels respectively.

The Theater Support Command (TSC) is at a level higher than that of the corps support command. Its mission is to maximize throughput and follow-on sustainment of Army forces and other supported elements regardless of the scale of operations. The TSC ensures that unit personnel, unit equipment, and commodities move to their point of employment with a minimum number of intervening stops and transfers. For this reason, the TSC establishes command of support operations and controls the distribution system before deploying elements arrive in the area of operations. The TSC provides overall sustainment support to Army forces. This support may include interim tactical-level support to early deploying corps and divisional elements.

Personnel, Equipment, and Supply Authorization Documents

There are a half dozen or so documents that authorize unit personnel, equipment, and supplies for Army forces. Examples include tables of organization and equipment (TOE), modified tables of organization and equipment (MTOE), tables of distribution and allowances, common tables of allowances (CTA), technical manuals, load lists, and stockage listings. A TOE lists all the personnel slots, skills required, and Class VII equipment that the Department of the Army has authorized a specific type of unit. TOEs normally are published at the battalion or separate company level and are models. Since different commands within the Army have different needs based on regional threats or environmental considerations, TOEs are used for MTOEs. For instance, a light infantry battalion in Alaska and one in Hawaii will be based on the same TOE. However, the actual MTOEs that each has will be different. The battalion located in Alaska will be authorized more cold weather gear, for example. By using the Web-based Total Army Authorization Document System software at https://webtaads.belvoir.army.mil/usafmsa/, logisticians can review the MTOEs for most, if not all, units within the Army. A password can be obtained by visiting the site.

Tables of distribution and allowance contain the same type of information as MTOEs except TDAs provide personnel and equipment authorizations for units generally considered nondeployable. These units normally are associated with organizations that support fixed facilities like installations or hospitals.

Common tables of allowance authorize expendable and durable supplies for both MTOE and TDA units but do not authorize Class VII items. Examples of common tables of allowances are the CTA 8-100 Army Medical Department Expendable and Durable Items (31 August 1994), CTA 50-900 Clothing and Individual Equipment (1 September 1994), CTA 50-909 Field and Garrison Furnishings and Equipment (1 August 1993), and CTA 50-970 Expendable/Durable Items—except: Medical, Class V, Repair Parts, and Heraldic Items (21 September 1990).

Army technical manuals describe how to operate and maintain Class VII items; they also serve as authorization documents for the expendable, durable, and nonexpendable supplies required to operate or maintain the Class VII items. Most of the Army's technical manuals can be viewed online by visiting the following Web site: http://www.logsa.army.mil/pubs.htm.

Basic loads, prescribed load lists (PLL), and authorized stockage lists also authorize durable and expendable items. Determining how much sustainment units will be allowed to stock perpetually is one of the Army's biggest logistics challenges. On the one hand, the more sustainment a unit brings to the fight, the longer it can operate without external support, and the less chance it will not have what it needs to accomplish its mission. On the other hand, the more sustainment a unit carries, the more strategic and tactical lift assets are required to move the unit. Greater unit-level sustainment also requires additional storage assets and greater funds tied up in inventory. For these reasons, units and support battalions are authorized to store and deploy with only a limited amount of sustainment stock. Sustainment stocks that accompany units during deployments are known as combat loads. The inventory associated with unit-level Class IX combat loads is known as the PLL. At the support battalion level, which provides additional sustainment to units, this inventory is known as the authorized stockage list. Authorized stockage lists are established for specific classes of supply, although bulk fuel, ammunition, and medical supplies are stored and accounted for separately from Class I, II, III (P), IV, VI, and Class IX. A detailed discussion of medical logistics, major end items, and ammunition is outside the scope of this article. While PLLs are intended for the owning unit only, authorized stockage lists are intended for all the *customer* units of the support battalion. Typically, a unit deploys with a 3-day combat load of Class I and bottled water; a 15-day combat load of packaged petroleum, oil, and lubricants; little or, perhaps, no Class IV barrier materiel; a basic load of Class V (normally a day of supply if actively engaged with the enemy); a 15-day supply of Class VI; no excess Class VII items; a small amount of Class VIII; and about 100 PLL lines of Class IX, most with a depth of only two or three items. Supply support activities will deploy with as much as they can, given their limited transportation and storage assets. Once deployed, supply support activities have to be resupplied, sometimes in 3 days or less, depending on the class of supply and the availability of host-nation support. Bulk fuel, bulk and packaged water, rations, and ammunition are quickly consumed.

Transformation

Improving logistics support is one of the key focuses of the planning associated with the Army's future force, a key part of which will be a new vehicle, under design, called the Future Combat System. The Future Combat System will have many of the same features of an M1 tank or an M2 Bradley fighting vehicle except it is envisioned to be much lighter. Current specifications state that it must be transportable by a C-130 aircraft.

While the Future Combat System will be part of a future force, a light armored, wheeled vehicle—the Stryker— already has been fielded and is a key component of the SBCT, formerly called the Interim Brigade Combat Team. The SBCT has 327 Stryker vehicles, and the brigade is roughly half the weight of an armored brigade and twice the weight of a light infantry brigade. The Army's short-term goal is to be able to deploy one SBCT in 4 days, a current division in 5 days, and five divisions within 30 days. With add-on reactive armor, the Stryker can withstand small arms, heavy machinegun, and handheld rocket-propelled grenade fire. A Stryker's combat-capable weight does not exceed 19 tons. All the vehicles and equipment of the entire SBCT weigh about 13,000 short tons. Excluding fuel and water, 3 days of sustainment for an SBCT weigh about 2,500 tons.

The Army's traditional brigade, divisional, corps, and ASCC structure also is being reviewed. The number of higher headquarters will be reduced. Brigades and portions of divisions will be organized into a modular force called units of action. These will contain the traditional maneuver battalions, along with some combat support and combat service support traditionally provided by divisional or corps units. The Army envisions three types of maneuver units of action: armored units of action will have about 3,800 persons and 1,000 vehicles; infantry units of action will have about 3,000 persons, and Stryker units of action will have about 4,000 persons. There also will be aviation units of action and sustainment units of action. All told, there will be 21 infantry units of action, 22 armored units of action, and 5 SBCTs. The Army's goal is to have 48 active component units of action and 32 National Guard units of action. The higher level command and support organization for the units of action will be called a unit of employment (UE) (x). This one level of command will be able to conduct many of the same command and control missions being performed by the two levels of command associated with divisions and corps. A UE (x) will be capable of commanding at least six units of action, to include a marine expeditionary brigade or a portion thereof. A different type of UE—this one currently designated with a (y) versus an (x)—will serve at a higher level than the UE (x). The UE (y) will conduct many of the command and control missions formerly provided by the two levels associated with corps and ASCCs.

Additional Logistics Resources

In addition to the excellent logistics-related databases that LOGSA maintains, the Army has other Web sites that are invaluable to the joint logistician. For instance, Army Knowledge Online (AKO) at https://www.us.army.mil/portal/portal_home.jhtml is the official portal serving as the primary information management tool for the Army. All soldiers, Army retirees, DoD contractors, members of Federal agencies, and members of the other services can apply for a password. Having an AKO password allows users access to many other logistics portals managed by Army activities. The Army Command and General Staff College's Department of Logistics and Resource Operations maintains an informative Web site at http://www-cgsc.army.mil/dlro/ and so does CASCOM at http://www.cascom.army.mil/.

Conclusion

The Army is structured to deploy to remote locations worldwide as part of a joint force. It has unique logistics challenges because of the distributed, noncontiguous methods of its employment. Providing logistics support to Army forces is made even more difficult by the diversity of equipment and by the dispersal of its forces. The Army is undergoing a major transformation of its force so that it can deploy large forces much more rapidly than it has in the past.

Notes

1. AMC, LOGSA [Online] Available: www.logsa.army.mil.
2. AMC, Major Subordinate Commands [Online] Available: www.amc.army.
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Mr Bates is a senior analyst with Alion Science and Technology and works at the Joint Forces Command, J-9 Transformation in Suffolk, Virginia.

("Using the Airfield Simulation Tool for Airfield Capacity-Capability Assessment" continued from page 40)

3. Author's interview with 1st Lt Jefferson DeBerry, 88th Airfield Operations Flight, Wright-Patterson AFB, Ohio, 18 Jan 02.
4. Author's interview with Duane Ward, representative for freight contractor, Wright-Patterson AFB, Ohio, 22 Jan 02.
5. Author's interview with Col Dennis D'Angelo, 88th Logistics Group, Wright-Patterson AFB, Ohio, 11 Jan 02.
6. Ward; Statement of Work from Freight Operations Contract, Oct 98.
7. Air Force Pamphlet 10-1403, 1 Mar 98.
8. Author's interview with Lt Col Ronald Warner, Aeronautical Systems Center Chief of Safety, Wright-Patterson AFB, Ohio, 22 Mar 02.
9. Ward; Statement of Work from Freight Operations Contract.
10. DeBerry.
11. Author's interview with Billy Hassel, Air Force Flight Standards Agency, Andrews AFB, Maryland, 22 Jan 02.
12. Author's interviews with MSgt Marco Walton and TSgt Richard Meyer, 88th Airfield Operations Flight, Wright-Patterson AFB, Ohio, 18 Jan 02.
13. Author's interview with Tom Harris, Aeronautical Systems Center, Wright-Patterson AFB, Ohio, 23 Jan 02.
14. Author's interview with Col. Dennis D'Angelo, 88th ABW/CV, Wright-Patterson AFB, Ohio, 11 May 04.

Dr Swartz is assistant professor of logistics at the University of North Texas, Denton, Texas. At the time of the writing of this article, he was on the graduate faculty at the Air Force Institute of Technology, Wright-Patterson AFB, Ohio. Captain Mingee is assigned to the Air Force Officer Accession and Training Schools, Maxwell AFB, Alabama.

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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.

Part Grouping

Angioplasty for the Supply Chain

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.

Agile Combat Support

Colonel Michael C. Yusi, USAF

The Editorial Advisory Board selected "Part Grouping"—written by Colonel Michael C. Yusi, USAF, Vol XXVII, No 1—as the most significant article to appear in the *Air Force Journal of Logistics* in 2003.

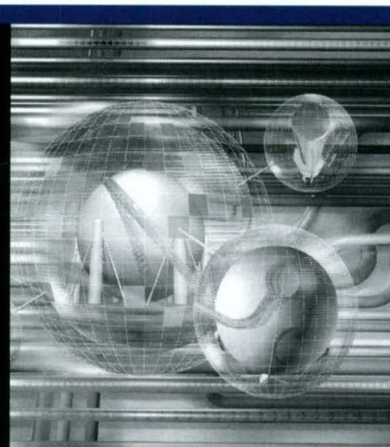
The Japanese were not the first to ignore the importance and vulnerability of logistics.

Oil Logistics

In the Pacific War

Lieutenant Colonel
Patrick H. Donovan, USAF

As long ago as 1187, history shows that logistics played a key part in the Muslim's victory over the Crusaders at the Battle of Hittin. The Muslim commander Saladin captured the only water source on the battlefield and denied its use to the Crusaders.



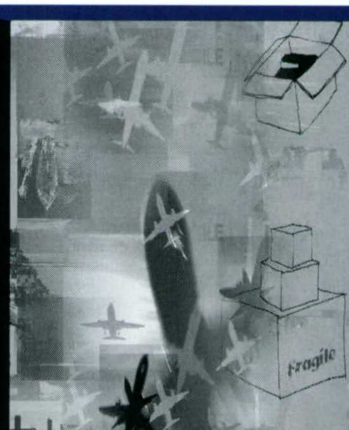
The Editorial Advisory Board selected "Oil Logistics in the Pacific War"—written by Lieutenant Colonel Patrick H. Donovan, USAF—as the most significant article to appear in Vol XXVIII, No 1 of the *Air Force Journal of Logistics*.

Lieutenant Colonel Joseph E. Diana, USAF

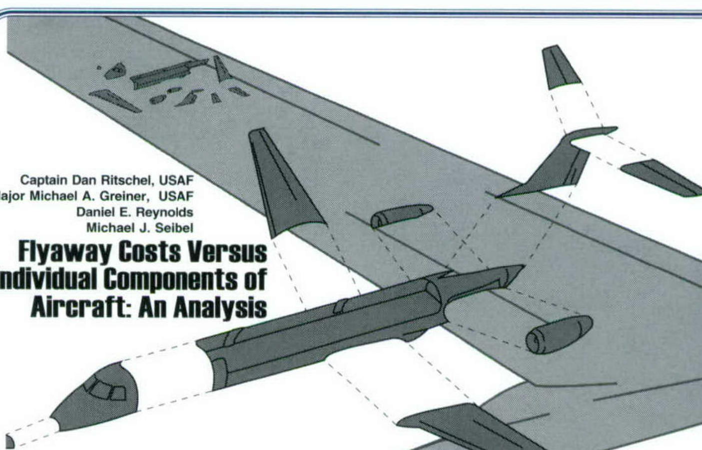
Improving Bare-Base Agile Combat Support

A Comparative Analysis Between Land Basing and Afloat Prepositioning of Bare-Base Support Equipment

To improve Air Force agility in establishing bare-base operations, RAND and the Air Force Logistics Management Agency analyzed current conditions separately and recommended potential solutions.



The Editorial Advisory Board selected "Improving Bare-Base Agile Combat Support: A Comparative Analysis Between Land Basing and Afloat Prepostioning of Bare-Base Support Equipment"—written by Lieutenant Colonel Joseph E. Diana, USAF—as the most significant article to appear in Vol XXVIII, No 2 of the *Air Force Journal of Logistics*.



Captain Dan Ritschel, USAF
Major Michael A. Greiner, USAF
Daniel E. Reynolds
Michael J. Seibel

Flyaway Costs Versus Individual Components of Aircraft: An Analysis

The staff of the *Air Force Journal of Logistics* selected "Flyaway Costs Versus Individual Components of Aircraft: An Analysis"—written by Captain Dan Ritschel, USAF; Major Michael A. Greiner, USAF; Daniel E. Reynolds, and Michael J. Seibel, Vol XXVII, No 4—as the best article written by a junior officer to appear in the *Air Force Journal of Logistics* in 2003.