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AIR FORCE JOURNAL of LOGISTICS

Volume XXVIII, Number 4
Winter 2004

AIR FORCE JOURNAL of LOGISTICS

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Volume XXVIII, Number 4 | Winter 2004 | AFRP 25-1

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New Journal Telephone Numbers - DSN 596-3357/3557 or Commercial (334) 416-3357/3557

The *Air Force Journal of Logistics* (*AFJL*), published quarterly, is the professional logistics publication of the United States Air Force. It provides an open forum for presenting research, innovative thinking, and ideas and issues of concern to the entire Air Force logistics community. It is a nondirective publication. The views and opinions expressed in the *Journal* are those of the author and do not necessarily represent the established policy of the Department of Defense, Department of the Air Force, the Air Force Logistics Management Agency, or the organization where the author works.

The *Journal* is a refereed journal. Manuscripts are subject to expert and peer review, internally and externally, to ensure technical competence, accuracy, reflection of existing policy, and proper regard for security.

The publication of the *Journal*, as determined by the Secretary of the Air Force, is necessary in the transaction of the public business as required by the law of the department. The Secretary of the Air Force approved the use of funds to print the Journal, 17 July 1986, in accordance with applicable directives.

US Government organizations should contact the *AFJL* editorial staff for ordering information: DSN 596-3357/3557 or Commercial (334) 416-3357/3557. *Journal* subscriptions are available through the Superintendent of Documents, US Government Printing Office, Washington DC 20402. Annual rates are $15.00 domestic and $18.75 outside the United States. Electronic versions of the *Journal* are available via the World Wide Web at: http://www.aflma.hq.af.mil/lgj/Afjlhome.html. The *Journal* editorial staff maintains a limited supply of back issues.

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Special Feature

Technology cannot be viewed as a separate entity within either the military or society in general. This illusion of discreteness simply does not exist. It is and will remain an integral part of both. The real issue is to recognize that technology is a tool with limitations, and these limitations should be considered in reacting to particular situations.

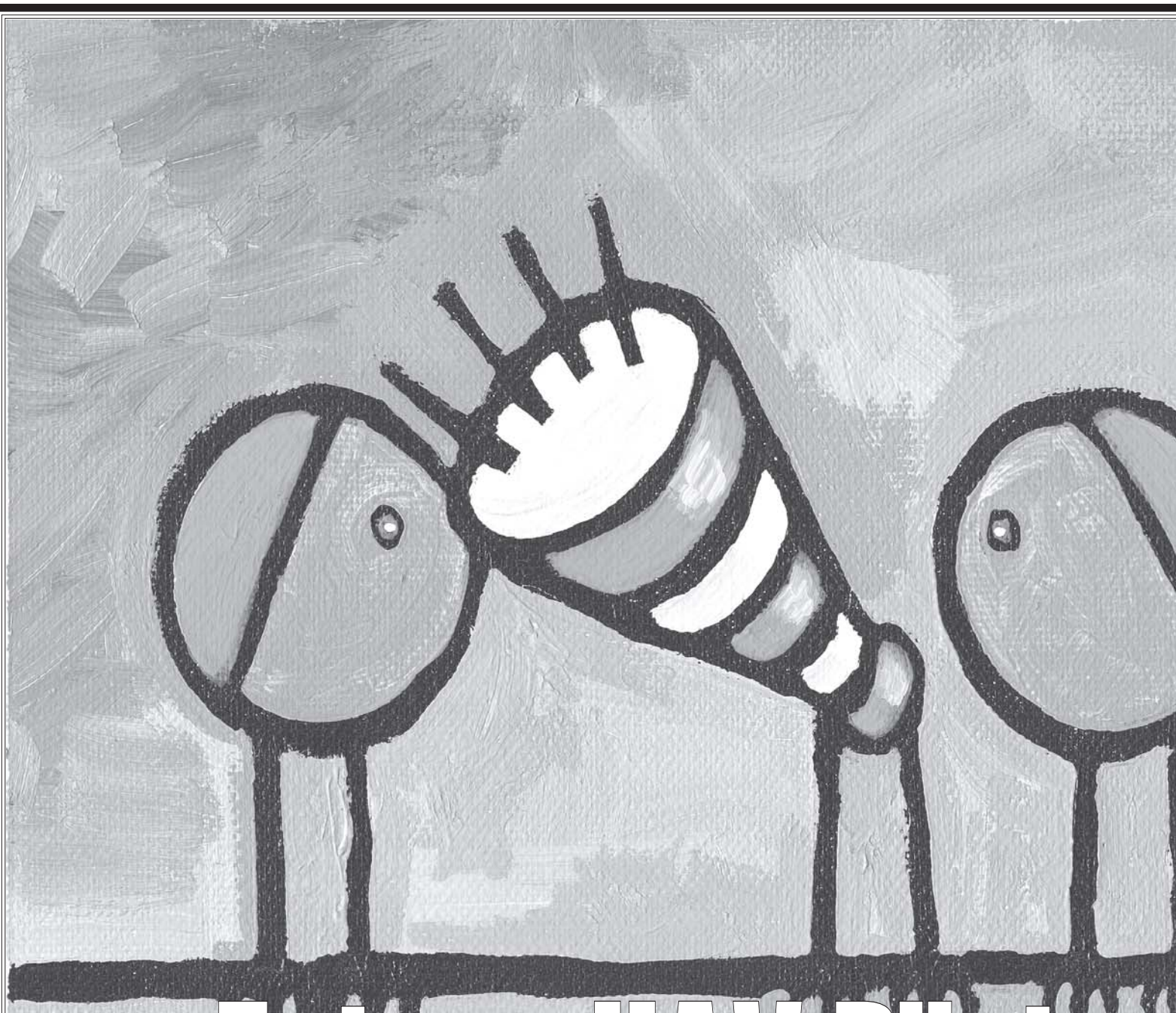
21st century logistics

Future UAV Pilots: Are Contractors the Solution?

RFID Technology: Is the Capability a Boon or a Burden for DoD?

Two evolving facets in the fabric of military logistics—technology (to include technological change and technological innovation) and the increasing use of contractors covers a lot of ground and often enjoins heated debate. Each has been looked on as a major tool for dealing with problems seen at the end of the 20th century and now in the 21st century. Recent changes—order of magnitude changes—in technology have led to both long-range and strategic planning efforts that integrate current and future technological advances into operational concepts. Similarly, the military has been expanding the use of contractors and contractor support into quasimilitary areas.

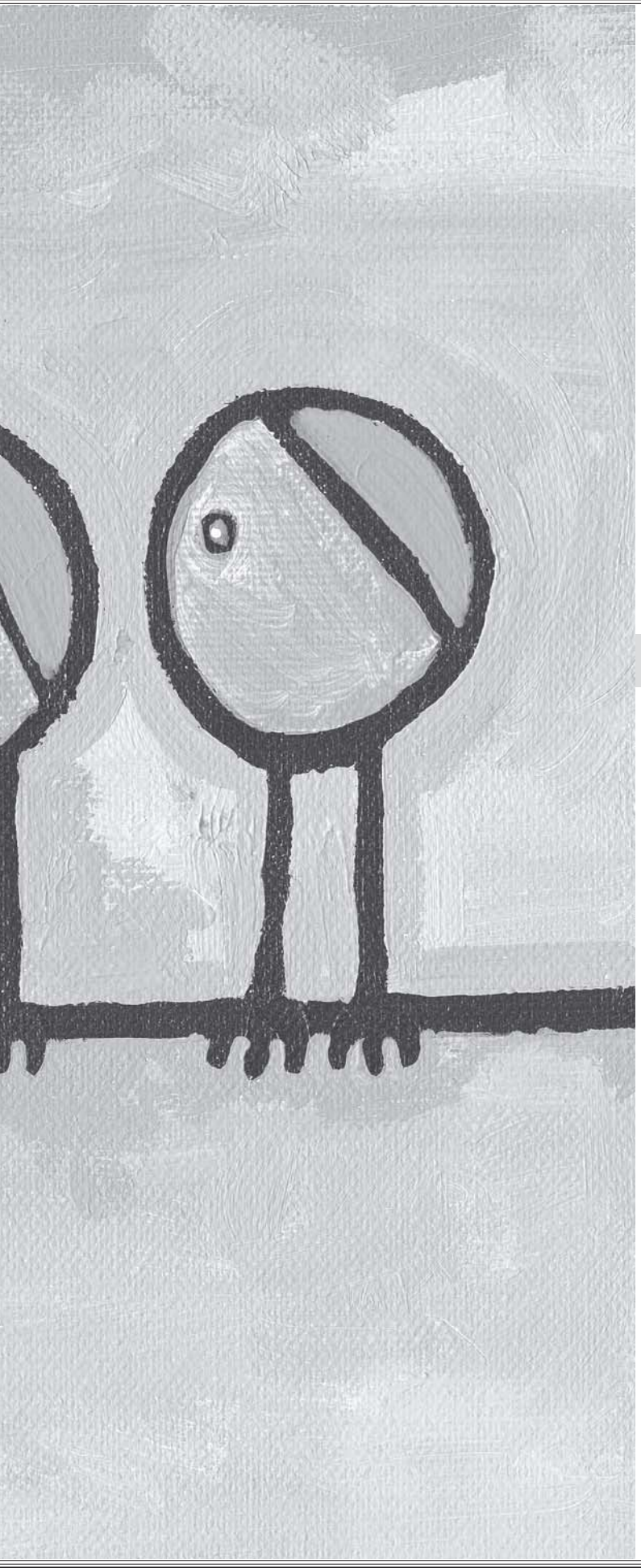
One such area is operating and maintaining unmanned aerial vehicles (UAV). In the first feature article -in the edition of the *Journal*, the authors examine several of the key issues associated with UAV operations—predeployment training, combatant status, and command authority. In the second feature, one particular aspect of technology is examined—radio frequency identification (RFID). From a Department of Defense perspective, the authors argue that RFID technology must be harnessed to ensure sustainment systems are able to support military forces in the transformation environment. They also examine the challenges associated with implement RFID technology.



Future UAV Pilots

Are Contractors the Solution?

The United States may find itself making even greater use of quasimilitary contractors to do a great deal of what looks like military business; for example, flying and maintaining UAVs.The use of contractor UAV pilots raises numerous issues such as predeployment training, combatant status, and command authority.



Lieutenant Colonel Michael J. Guidry, USAF
Colonel Guy J. Wills, USAF

Introduction

Special Feature

During the first-ever combat deployment of the RQ-4A Global Hawk unmanned aerial vehicle (UAV) in support of Operation Enduring Freedom, 56 contractors deployed as part of an 82-member military, civil service, and contractor team. Several of these contractors were needed to operate the vehicle during combat operations and served as Global Hawk pilots.[1] This was repeated during Operation Iraqi Freedom. Contractor participation in military affairs is not new. Contractors have supported military operations since the Continental Army. This support role has evolved over the years, with contractors now conducting combat-type operations. With the recent push for streamlined acquisition practices and spiral development, contractors will remain the initial cadre and best trained experts for all future UAV systems, systems that may be deployed into the combat arena well before initial operational beddown or trained military operators are available.

A contractor deployment force brings unique capabilities to the combat arena but creates unique situations for the deployment commander. Consequently, deployment commanders need to understand their role and responsibilities in preparing contractors for a combat deployment. Once deployed, the deployment commander and contractor need to understand their roles and responsibilities with respect to command authority, rules of engagement, force protection, and the basic care and feeding of the team. More important, the deployment commander needs to understand the numerous legal issues created with respect to the contractor pilots' combatant status, prisoner-of-war (POW) status, and the legal status with respect to the host nation's legal system.

If the United States is going to continue using contractor UAV pilots in combat operations, there are three options available to clarify the role, relationship, and responsibility of the deployment commander and contractor workforce. First, the United States can do nothing and assume the risk of using potential unlawful combatants, with possible criminal repercussions against these individuals and those who direct their operations. Second, the United States could implement a sponsored reserve program, which places a portion of the contractor force in a military reserve status. This status allows for the callup of contractors to military active-duty status if their specialized combat support is needed. Finally, the United States can try to alter the treaties and redefine

lawful combatants, a process that would be expected to take some time.

Contractors in Combat: Here to Stay

Throughout history, civilians have played an important role in military operations. Over time, their role has transformed from battlefield support to combat operations. As technology becomes more complex and the military continues to downsize, contractors will play a greater role in combat operations, a role that is sure to increase as the Department of Defense (DoD) strives to field weapon systems sooner.

From the Revolutionary War to Gulf War II

In the 18th century, contractors served in many tasks—as carpenters, engineers, and wagon drivers in support of the Continental Army.[2] Their efforts allowed the soldiers to focus on warfighting-related tasks. The contractors' role has evolved over the years, and their participation in the combat arena has increased. During Operation Desert Storm, 9,200 contractors deployed to support military operations.[3] Their roles have increased over the years, to include airborne support operations. During Operation Joint Endeavor over Bosnia, contractor personnel conducted airborne surveillance missions as crewmembers on the Joint Surveillance Target Attack Radar System Aircraft.[4] By 1996, the civilian-to-military ratio had increased to one out of ten in support of Bosnia operations.[5] As our active-duty military force downsizes, privatization of military functions increases. From 1989 to 1999, the active-duty force was reduced from 2,174,000 to 1,453,000.[6] Meanwhile, the military continued to fill its inventory with sophisticated equipment, increasing the military's dependency on civilian specialists or contractors. "Highly technical and complex weaponry is flooding the Armed Forces, requiring contractors to be hired to train military operators and maintain and operate the systems."[7] Consequently, civilian contractors play an important role in current military peacetime and contingency combat operations. Recent operations in support of Operations Enduring Freedom and Iraqi Freedom have used contractors in a variety of roles, from logistics support to UAV operations. This dependency or support was not unexpected but fully supported by the DoD. In a letter to all Air Force program executive officers (PEO), the Principal Deputy Assistant Air Force Secretary for Acquisition and Management emphasized the Air Force's desire for elevated contractor support. This individual wrote:

> I will support you (PEOs) in the liberal use of undefinitized contract actions, urgent and compelling justification and authorizations, options for increased quantities, accelerated delivery options, and so forth...to ensure your government-contractor teams are geared up for this war effort.[8]

As technology becomes more complex and the military continues to downsize, contractors will play a greater role in combat operations, a role that is sure to increase as the DoD strives to field weapon systems sooner.

Figure 1. RQ-4A Global Hawk Over California

This commitment was echoed throughout the DoD. According to Secretary of Defense Donald H. Rumsfeld, "During Operation Iraqi Freedom, more than 80 percent of civilians deployed in the theater of operations were contractors."[9] Such contractor commitments enabled the first-ever combat deployment of the RQ-4A Global Hawk. Today, the contractor's role has transitioned from support to conducting actual combat reconnaissance missions as Global Hawk UAV pilots were utilized during combat reconnaissance missions.

The Global Hawk is a high-altitude, long-endurance UAV designed to provide the joint force commander an extended reconnaissance capability through sustained high-altitude surveillance and reconnaissance. It can operate at ranges up to 3,000 nautical miles from its home or deployed base, with loiter capability over the target area exceeding 24 hours at altitudes greater than 60,000 feet. The Global Hawk carries a synthetic aperture radar and electro-optical (EO) and infrared sensors simultaneously, which provide broad coverage and continuous spot coverage. The aircraft is designed to operate autonomously but allows man-in-the-loop control at all times from a ground-based mission control element (MCE). This command-and-control facility can be located throughout the world from within

the area of operations or the continental United States (CONUS). Global Hawk's first flight occurred on 28 February 1998 from Edwards AFB, California.[10] In November 2001, in support of Enduring Freedom, 56 Global Hawk team contractors, including 5 contractor pilots deployed, in support of Enduring Freedom, alongside a few military counterparts.[11]

Prior to Enduring Freedom, in March 2001, the Global Hawk program "entered the first phase of formal defense system acquisition program," completing its advanced concept technology demonstration (ACTD).[12] The first developmental test aircraft has yet to be delivered to the Air Force Materiel Command for developmental flight testing, and its initial operational capability (IOC) date was not expected until sometime in 2006.[13] However, six RQ-4A Global Hawk aircraft have been built. During the ACTD, the Global Hawk demonstrated the ability to conduct high-altitude, precision reconnaissance during extended flights and conducted deployments to Eglin AFB, Florida, and to a Royal Air Force base in Adelaide, Australia, from Edwards AFB.[14] Because of these proven, yet limited, capabilities, it was sent to support both Enduring Freedom and Iraqi Freedom. Since these deployments occurred well in advance of its initial operating capability, the majority of pilots were contractors who were needed to conduct the actual combat missions.[15] According to Major General Joseph P. Stein, director of aerospace operations for Air Combat Command, "The Air Force's RQ-4A Global Hawk UAV generated 55 percent of the targeting data used to destroy time-sensitive targets in Iraq during Gulf War II."[16] Now contractors were conducting combat missions.

A Greater Role in the Future

This trend of deploying nonoperational weapon systems with direct combat contractor support only will increase in the future for multiple reasons, including Air Force manning practices, accelerated acquisition times, and further UAV concepts of operations (CONOPS) maturity. With respect to Air Force manning, changes are already in the works to produce UAV operators who will be assigned these duties as their first operational flying assignment. Secretary of the Air Force James G. Roche stated, "We recently directed that the Air Force reengineer navigator training to produce airmen equally proficient in employing both manned aircraft and UAVs. They will be known as combat system operators."[17] Until this training pipeline is functional and producing combat system operators, UAV pilots are former manned aircraft pilots or navigators,[18] who then undergo UAV-specific training. Regardless of the source of the UAV, the Air Force system is unable to provide military-trained UAV pilots to support unplanned combat deployments that occur during initial testing or concept development. Normally, the Air Force will not begin to man up the first operational unit until after a developmental weapon system is nearing completion of developmental test and evaluation. For example, the 12th Reconnaissance Squadron at Beale AFB, California, was designated the first Global Hawk operational squadron. Although the 12th was activated in October 2001, the first pilots were not programmed to arrive until January 2003. By this time, Global Hawk had flown more than 1,000 combat hours in support of the Global War on Terrorism,[19] and these pilots still had to undergo a 6-month training program before they were combat ready. Consequently, the only UAV pilots available to conduct combat operations were a handful of developmental/operational test pilots and contractor pilots. This time line for

Article Highlights

Contractors play an important role in military operations.

A contractor deployment force brings unique capabilities to the combat arena but creates unique situations for the deployment commander. Consequently, deployment commanders need to understand their role and responsibilities in preparing contractors for a combat deployment. Once deployed, the deployment commander and contractor need to understand their roles and responsibilities with respect to command authority, rules of engagement, force protection, and the basic care and feeding of the team. More important, the deployment commander needs to understand the numerous legal issues created with respect to the contractor pilots' combatant status, POW status, and the legal status with respect to the host nation's legal system.

manning an operational squadron will remain in place. If the Air Force were to allocate personnel and unit startup funding for every advanced concept demonstration program, well prior to a proven system demonstration of its initial system capabilities, legacy operational units' manning and funding would suffer greatly. The Air Force would waste an undetermined amount of money through this early startup if a demonstration did not go as planned or failed completely.

Another factor that will increase our reliance on UAV contractor pilots is the DoD's push to field new weapon systems quicker. Rumsfeld wants to reduce system acquisition times since "program start to initial operational capability is generally more than 8 years"[20] and, too often, stretches to 15 or 20 years for major weapons.[21] "The need to introduce new weapon systems swiftly is clear," stated Rumsfeld. He added, "The present weapon systems acquisition process…is ill-suited to meet the demand posed by an expansion of unconventional and asymmetrical threats in an era of rapid technological advances and pervasive proliferation."[22] Rumsfeld selected evolutionary acquisition or spiral development as the preferred approach to buying future weapon systems or weapons. Practically speaking, spiral development is done to provide rapid development of a project with quicker fielding of the system,[23] knowing there will be a less-than-perfect system in the beginning. This initial system will be able to meet some, but not all, of the user's requirements. Consequently, contractor pilots will play a greater role in combat operations if their particular weapon system demonstrates a unique capability early in the program. Such a possibility exists with the X-45 unmanned combat aerial vehicle (UCAV) demonstration program ongoing at Edwards AFB.

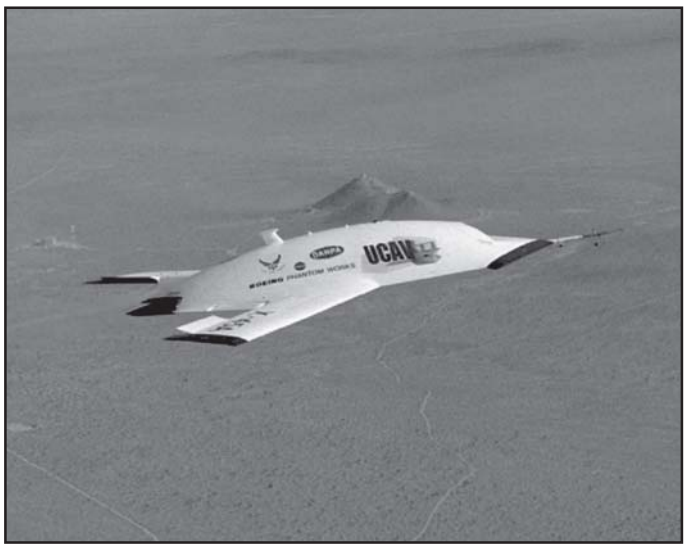


Figure 2. The X-45 Unmanned Combat Aerial Vehicle[24]

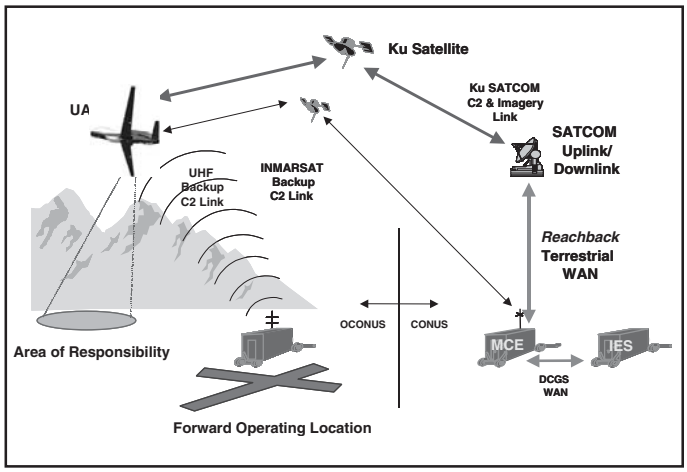


Figure 3. Reachback Command-and-Control Path[30]

The UCAV program is a joint effort "to demonstrate the technical feasibility, military utility, and operational value of a UCAV system to effectively and affordably prosecute 21st century lethal and nonlethal suppression of enemy air defenses and strike missions within the emerging global command and control architecture."[25] Similar in size to an F-117 but with the low-profile, flying-wing design of a B-2, the X-45 will operate in the same flight environment as manned fighter aircraft, which currently conduct suppression of enemy air defense missions. The X-45 is designed for internal carriage and release of two 2,000-pound joint direct attack munitions.[26] Like the Global Hawk, the UCAV is designed to operate autonomously with a pilot monitoring its activities from a ground-based command and control shelter. If necessary, the pilot can interrupt the autonomous flight and control the vehicle. The X-45 first flew in May 2002. Now the X-45 UCAV program is completing a demonstration to validate its ability to release a precision-guided munition and destroy a ground target representing a surface-to-air missile site or associated command-and-control facilities. "The DoD envisions employing UCAV weapon systems in the post-2010 battle space to augment the manned force structure on high-risk, high-priority missions where mission success and survivability are key."[27] Once the UCAV demonstrates the ability to destroy ground targets and a high-priority, high-risk mission exists, expect the UCAV to be called into action prior to operational fielding, just like Global Hawk. Although two military pilots are undergoing training, contractors are operating these vehicles, and the majority of initial operators are contractor pilots. If tasked to support combat operations, the deployment team, including the pilots, will consist primarily of contractors.

The military's reliance on UAV contractor pilots will continue to grow based on UAV CONOPS maturity, particularly with respect to UAV reachback operations. Reachback is "a concept that enables wide geographic separation of a UAV and its command-and-control element using satellite communications and a terrestrial wide area network."[28] Basically, reachback allows the military to perform UAV intelligence, surveillance, and reconnaissance collection missions over a remote area of responsibility from halfway around the world. During Iraqi Freedom, the Global Hawk was controlled from the United States while conducting combat reconnaissance missions over Iraq. According to the *Washington Times* and an Air Force source, "'Global Hawk played an extraordinarily important role in focusing precision airpower,' an Air Force source said yesterday, estimating that it quickened the Republican Guard's defeat by several days and is responsible for scores of tank kills."[29] Such precision airpower would not have been possible without UAV contractor pilots. Although some pilots were required to deploy forward, the majority of the UAV pilots were able to remain stateside and conduct combat missions. Reachback, depicted in Figure 3, is favorable to both the military and the contractor. The

military is content because of the reduced logistical footprint and minimal predeployment training requirements. The contractor is satisfied since fewer people will be deployed to a combat area, and more contractor pilots may agree to participate. Overall, this concept easily lends itself to a greater role of UAV contractor pilots in combat operations.

Legal Implications

The trend for the Air Force to rely more and more on contractor UAV pilots has raised numerous legal issues: combatant status with respect to the Law of Armed Conflict (LOAC), POW status, and the contractors' role with respect to status of force agreements (SOFA). The deployment commander must understand the legal implications of utilizing contractors as UAV pilots and the contractors' status with respect to international and host-country laws.

Civilian Vice Contractor

Prior to addressing legal issues raised with respect to using contractors in combat operations, the term contractor must be defined with respect to other civilian designators. Normally, civilians fall into three categories: DoD civilian employees, nonaffiliated civilians, and contractors. DoD employees encompass civilian support personnel, the American United Services Organization, and civilian aircrew members. Nonaffiliated civilians are those civilians who share common interests with the military and include the media, nongovernmental organizations, private voluntary organizations, and intergovernmental organizations. Contractors are those individuals or employees of an organization under contract with the DoD.[31] This article focuses on contractors. Contractors traditionally are split into three categories: deployed systems contractors, external theater support contractors, and internal theater support contractors. The Air Force General Counsel defines deployed systems contractors as "US companies that provide operational support to military systems (for example, Predator, Global Hawk) wherever those systems may be deployed in the world." [32] For this article, UAV contractor pilots will be considered deployed systems contractors even if conducting UAV operations stateside via reachback operations.

International Law and the Contractor

An important aspect of the Law of Armed Conflict is the distinction it creates between combatants and noncombatants. Combatants are "those persons who have the right under international law to participate directly in armed conflict during hostilities."[33] According to Article 43(3) of the Geneva Conventions, "Members of the armed forces of a party to a conflict are combatants; that is to say, they have the right to participate directly in hostilities."[34] For clarification, a member of the armed forces or military is someone who meets all the following conditions:

- Be commanded by a person responsible for his subordinates.
- Have a fixed distinctive emblem recognizable at a distance.
- Carry arms openly.
- Conduct operations in accordance with the laws and customs of war.[35]

Consequently, if an individual takes part in hostilities without being a member of the armed forces (does not meet all of the four previously mentioned criteria), that person is an unlawful combatant, not just a noncombatant. An unlawful combatant is an individual who is not authorized to take part in hostilities but does so anyway whereas a noncombatant is a person who is not authorized to take an active role or direct part in hostilities and does not.[36] The key term here is *does not*. If they are noncombatants and take a direct or active role in hostilities, then they are unlawful combatants. Civilians who accompany the force in deployed military operations are considered noncombatants. According to the Air Force, "Civilian contractor personnel accompanying Air Force forces are not combatants and must not be allowed to act as combatants during Air Force operations."[37]

As stated earlier, Global Hawk contractor pilots conducted combat reconnaissance missions during both Enduring Freedom and Iraqi Freedom.[38] A determination whether they are lawful combatants, unlawful combatants, or noncombatants requires a review of the LOAC's definition of combatants stated earlier. First, contractor pilots need to have the right to take part in hostilities, a right only granted to the military. Recall those four rules for identifying a military member. "The requirement for distinctive emblems (most often a uniform) and carrying arms openly exists to distinguish combatants from noncombatants."[39] Plus a defined chain of command is necessary primarily for discipline and to ensure operations are done in accordance with international law. Although they were contractor personnel accompanying the military force, they were not an integral part of the military or a separate military force. Consequently, UAV contractor pilots who conduct reconnaissance missions in Iraqi Freedom and Enduring Freedom could be considered as taking direct part in hostilities in violation of the Laws of Armed Conflict, making them unlawful combatants. As an unlawful combatant, a UAV operator who conducts combat missions (participating in hostilities) could be prosecuted as a criminal.[40]

An unlawful combatant is an individual who is not authorized to take part in hostilities but does so anyway whereas a noncombatant is a person who is not authorized to take an active role or direct part in hostilities and does not.

Of course, some will argue that UAV pilots still can be considered noncombatants since their reconnaissance missions do not impact the enemy forces or the enemy facilities directly. However, the US military takes a firm stance in its definition of direct participation to even include lookouts or guards as direct participants. The Air Force further stated, "Being a member of a weapons crew or…a crewman on a military aircraft in combat" is active participation.[41] Consequently, it is easy to deduce that people who control reconnaissance vehicles over enemy territory are participating in hostilities whether they are in the same area of operations or stateside. By collecting reconnaissance information, they intend to destroy or disrupt the enemy or various enemy capabilities.[42] Finally, had the UAV been declared operational and beddown at an operational base, contractor pilots would have been replaced with military pilots, indicating the military's desire to conduct combat operations with lawful combatants only. These are just a few reasons to implicate contractor UAV pilots who are conducting a combat mission as unlawful combatants.

POW Status

Equally important is determining what protection would be offered contractors if they are taken as prisoners of war. Article 4 of the Third Geneva Conventions describes how members of an armed force, as well as persons who accompany the armed forces without actually being members thereof, are entitled to POW status.[43] Army Field Manual 100-10-2 states, "If captured, a contractor's status will depend upon the type of conflict, applicability of any relevant international agreements, and the nature of the hostile force."[44] Normally, a contractor would be considered a noncombatant, and all noncombatants are protected persons and are afforded some level of enhanced protection under the Law of Armed Conflict.[45] As determined in the preceding paragraph, the UAV contractor pilots could be considered unlawful combatants. Although they may retain POW status, they could be tried for war crimes.[46] According to the US Supreme Court:

> Lawful combatants are subject to capture and detention as prisoners of war by opposing military forces. Unlawful combatants are likewise subject to capture and detention, but in addition, they are subject to trial and punishment by military tribunals for acts which render their belligerency unlawful.[47]

Status of Force Agreements

Combatant status and POW treatment deal primarily with international law. The deployment commander must understand the relationship contractors will have with the host nation's laws and legal system. One of the greatest challenges facing the deployment commander of contractor personnel is determining the contractor pilot's status while in the deployed country with respect to legal agreements or SOFAs. Deployment commanders need to work this issue with the staff judge advocate's office as soon as they are notified of an upcoming deployment that utilizes contractor personnel. A SOFA is defined as "Any type of binding international agreement that seeks to order and arrange the competing legal and jurisdictional claims of receiving and sending states."[48] These SOFAs are necessary since they are legally binding, international agreements that create a legal status that, absent the agreement, would not otherwise exist. Currently, only 5 of 109 SOFAs contain language that addresses contractors who support military operations.[49] Deployment commanders should seek the same protection or legal status for their contractor workforce that is afforded military personnel. The State Department is responsible for this SOFA; therefore, they should be contacted for assistance. Without a SOFA, the contractor is basically a tourist in the deployed or host country and subject to all the host nation's laws.

Conducting Contractor Operations

Preparing a military or contractor team for deployment of an established weapon system is not an unusual experience. Preparing for a combat deployment with a weapon system, which has not even reached its first operational base, is a whole different story.[50] Such a system still may be in concept development with unique support equipment, undocumented procedures, and a workforce primarily made up of contractors.

Combatant status and POW treatment deal primarily with international law.

> Employing a developmental aircraft without combat crew training, validated and verified technical data, and operations guidance is not routine and may create concern among crews accustomed to robust training and compliance with Air Force and major command instructions and policies.[51]

Military deployment commanders need to understand their roles and responsibilities in preparing the entire team, including contractors, for a combat deployment and in carrying out the mission while deployed.

Team Preparation

Once a decision has been made to deploy an unfielded UAV system, the contractor pilots need to be treated just like military pilots in preparation for a deployment. According to Joint Publication (JP) 1-0, "DoD civilians and contractor employees deployed for military operations will be provided the same support and services provided their military counterpart."[52] Commanders will provide the necessary resources to support, train, clothe, equip, and sustain the civilian workforce in the operational area. Contractors need to undergo various forms of training, receive intelligence and legal briefings, be issued equipment, and ensure they are medically fit to deploy. The military will provide nuclear, biological, and chemical defense training, basic first aid and firearm safety to the contractor.[53] Weapons certification may or may not be accomplished for the contractors, as contractors will be issued firearms for self-protection only. According to JP 1-0, commanders, with approval from combatant commanders, may issue contractor personnel

firearms when unusual circumstances exist and the contractor has received the necessary training.[54] Since training may not be available once deployed, the local commander may want to conduct weapon certification. The judge advocate or legal office needs to explain Geneva Convention provisions, the Uniform Code of Military Justice (UCMJ), and the Code of Conduct.[55] Normally, base readiness or mobility personnel will conduct this training. However, the base readiness section may not be able to support such an unexpected training requirement. With a stable, fielded weapon system, the mobility or readiness officer already has identified those military or DoD civilians who will deploy and assigned them to various mobility positions. Within this system, the mobility officer is able to track completed training, forecast training requirements, and meet the training demand with an adequate number of instructors and trainers and class dates. The same logic applies to equipment. With an established system and deployment personnel previously identified, equipment will be stockpiled on base or at a known location. The deployment commander may need to borrow equipment from other bases and create a unique training schedule to train and equip the deployment force. When a contractor force on a concept development or pre-operational weapon system requires deployment training and equipment issue, the deployment commander needs to remain flexible and become creative in scheduling training and acquiring the necessary deployment equipment.

The base medical support agencies will conduct medical and dental examinations; psychological evaluations to ensure fitness of duty and HIV testing are optional.[56] These examinations can overwhelm the base medical support team, depending on the time line and size of the deployment team, just like the base readiness employees. Information produced from the medical exam is critical in determining the overall wellness of contractors and their deployability status. A traditional military member's health status is well-documented whereas a contractor's overall health condition is an unknown. Certain inoculations could do more harm to the contractor than good. It is imperative that contractors undergo physical fitness and medical exams once they are notified of a possible deployment. The Air Force medical team also will inoculate contractors with the necessary immunizations for the specific country they will deploy to. Depending on the demand, this requirement can overwhelm a base's supply system. Anthrax and smallpox vaccinations are mandatory.[57] Refusal of certain inoculations may result in a nondeployable status. The requirement for these numerous inoculations makes the fitness exam a definite requirement. The deployment commander needs to be prepared to insert other contractors into the deployment team as existing team members are classified nondeployable. Once again, flexibility and resourcefulness are key.

Just like military personnel, contractors will require official identification cards that will serve to record their Geneva Convention status. Contractor pilots will be issued a DoD Form 489, Geneva Conventions Identity Card, or common access card, which contains similar information, along with personal identification tags (dog tags). These tags will contain full name, social security number, blood type, and religious preference. Contractors are required to wear these identification tags at all times when deployed, just like their military counterparts.[58] Although identification tags are mandatory, contractor uniforms are optional. The contractor must not wear a uniform except for unique circumstances. If uniforms are worn, commanders are to ensure contractor uniforms are clearly distinguishable from military uniforms.[59] "Contractors who accompany the force are not authorized to wear military uniforms, except for specific items required for safety or security, such as chemical defense equipment, cold weather equipment, or mission-specific safety equipment."[60] Uniforms are used to distinguish combatants from noncombatants or enemy combatants.

The military will provide legal assistance for deploying military personnel to produce a last will and testament, power of attorney, or other necessary legal documents (when a lengthy absence is expected). "Contractor personnel generally will not be eligible to receive legal assistance from military or US government civilian attorneys."[61] However, such legal assistance may be made available for combat deployments if it is included in the contract that covers the deployment. Regardless, the deployment commander needs to ensure deploying contractors have their legal needs in order. Still, there are outstanding issues, which are not easily addressed, such as life insurance. Since the "military environment is inherently dangerous and may result in death or personal injury"[62] to the contractor or damage to the contractor's property, life-insurance companies are reluctant to provide insurance for individuals in a combat zone. Once in combat conditions, the contractor's life-insurance policies may be voided or the premium driven sky high. According to Mike Klein, president of MMG Agency, Inc, a New York insurance firm, "Insurance rates for civilians skyrocketed—from 300 percent to 400 percent more than normal."[63] There is the possibility a deployed contractor may be entitled to compensation from the Government or from the contractor's company insurance policy. This is a complex topic and requires a review of the Longshore and Harbor Workers Compensation Act,[64] Defense Base Act, and War Hazards Compensation Act.[65]

Deployment Practices and Procedures

Once deployed, deployment commanders need to fully understand their role and responsibilities with respect to force protection, the basic care of their mixed military contractor team, command authority, discipline, and rules of engagement. The terms of the governing contract will dictate how deployment commanders handle numerous situations. The deployment commander's primary concern is the safety of the team. Depending on the situation, force protection of contractors is the responsibility of the contractor, the chief of missions[66] to the country deployed, or the deployment commander. Issues related to force protection off base might require discussions with host-nation officials and contracting officers. These issues may be addressed in the SOFAs. During some contractor deployments, contractors have resided in off-base quarters that do not offer protection and create significant force-protection concerns.[67]

Deployment commanders must take care of their team in country with respect to basic necessities.

> Generally, the terms of contracts that contemplate performance in deployed locations will dictate that living conditions, privileges, and limitations of contractor personnel should be equivalent to those of the units supported unless the contract with the Government specifically mandates or prohibits certain living conditions.[68]

The military may provide for basic necessities such as lodging, food, and transportation in country, but these issues need to be identified in the contract.[69] Medical care for contractors may be

made available during contingency operations,[70] but again, the specifics, including level of care, must be covered in the contract.

The greatest challenge to deployment commanders is in understanding their command authority with a contractor workforce. According to Air Force Pamphlet (AFP) 10-231, civilians may be subject to military law when serving with or accompanying an armed force *in time of war*. However, the US Supreme Court has ruled *in time of war* to mean a congressionally declared war and not contingency operations.[71] If war is declared, civilians will be subject to the UCMJ. This allows the military commander, who is responsible for those activities in which contractors are participating, to discipline the contractors when necessary. The last time Congress declared war was in 1941 as America entered World War II. Since then, the United States has been involved in military operations other than war or contingency operations without an official declaration of war. Without this war declaration, military commanders have no command authority over contractor personnel. A contractor cannot be ordered to do anything, including the services defined in a contract. "The warfighter's link to the contractor is through the contracting officer or the contracting officer's representative."[72] "Control of civilian contractor personnel is tied to the terms and conditions of the government contract; therefore, key performance requirements should be reflected in the contract."[73] Consequently, the deployed commander needs to understand fully the contractual relationships as outlined in the contract. The wording in this contract impacts a variety of areas, including basic needs, medical assistance, and security arrangements. The contracting official needs to fully document command authority and disciplinary actions and procedures in the contract, which guide deployed contractor actions.

"This lack of command authority over civilian contractors presents a burden on commanders who are accustomed to having their orders carried out."[74] The contract may not cover all contingencies. Consequently, contractor actions may be detrimental to the operation, but commanders may have no recourse for discipline as they would with a military member. During Iraqi Freedom, "US troops suffered through months of unnecessarily poor living conditions because some civilian contractors hired by the Army logistics support failed to show up."[75] According to Peter W. Singer, author of *Corporate Warriors*, "Untrained civilians can walk off the job any time they want, and the only thing the military can do is sue them later on."[76] The contract does not provide penal authority for military commanders to enforce orders to civilian personnel.[77] Although deployment commanders may not have UCMJ authority over their contractor workforce, they may have *hire and fire* authority, if stipulated in the contract. If the commanders are not satisfied with the performance of a particular contractor, they can have that person removed from the deployment team. The loss of a job and related source of income may be a significant motivator for the contractor to conform to the rules and regulations or demands of the commander.[78]

A major area of concern for the commander when dealing with aircraft operations is adherence to rules of engagement (ROE). All military aviators have received ROE training since their initial operational assignment. Contractor pilots need to be educated on rules of engagement and need to comply with these rules. ROE are defined as "Directives issued by competent military authorities that delineate the circumstances and limitations under which US forces will initiate or continue combat engagement with other forces encountered."[79] Rules of engagement ensure that national policies and objectives are reflected in the action of the commanders in the field. Since the deployment commander will rarely, if ever, have UCMJ authority over contractors, specific criteria need to be identified in the contract to ensure contractors comply with the rules of engagement and what actions the commander can take if ROE violations occur. Similar contract clauses need to be developed that discuss LOAC violations and failure to perform. Contract clauses should focus on motivating actions to succeed versus punishment if failure occurs.

Solutions

Contractors not only provide a vital service but also may be the only individuals trained to operate a particular weapon system. Consequently, they may play an important role in combat operations. However, their use creates unique challenges for the deployment commander, including deployment preparation, command authority, and combatant status. There are several methods to deal with the issues raised by the use of contractors in combat operations, which would assist deployment commanders in conducting their mission. Three methods or solutions will be discussed: do nothing and accept the risks of current practices, use a sponsored reserve, or seek to change Hague and Geneva conventions by creating a combatant contractor legal category.

Do Nothing and Hope for the Best

The first solution is to keep the current practice and accept the risks associated with UAV contractor pilots who conduct combat operations. This may seem a reasonable choice, particularly if military commanders always rely on reachback operations in conducting UAV operations. Reachback operations give the contractor the protection of stateside basing and security. Although some pilots will need to deploy to the launch and recovery base, these pilots will control the vehicle only in friendly or neutral territory before handing off control of the vehicle to CONUS-based pilots. Therefore, their status could be considered noncombatants. Of course, this solution would work as long as the United States continues to win these small-scale contingencies and the contractor pilots' risk of being captured remains low.

Sponsored Reserve Solution

Similar to changing the rules is to use what the Air Force Directorate of Strategic Planning has termed sponsored reserve. The Air Force defines sponsored reserve as:

> ...a contract or agreement between the military and a providing contractor or government agency, which includes a provision that a specified portion of the provider's workforce will be members of a military reserve component (Guard or Reserve) as a condition of employment.[80]

The development of a sponsored reserve involves a variety of issues, ranging from legal to fiscal.[81] Simply stated, members of the contractor's workforce would be designated as part of the DoD's inactive reserve force. These contractors turned reservist would be recalled when needed for contingency operations in accordance with established regulations. Prior to their recall, the selected contractors would be trained per standard mobility requirements. This policy would be in effect until the Air Force

establishes the initial operating capability for the weapon system. A similar policy is already in effect in the United Kingdom. The United Kingdom Sponsored Reserve Act requires each defense contractor "to have a specified number of its employees participate as military reservists."[82]

Rule Change: A Lengthy Process

A long-term solution—the opposite of doing nothing—is to change the rules that govern the Law of Armed Conflict and those that determine combatant status. The Law of Armed Conflict results from "Hague Law (named for treaty negotiations held over the years at The Hague, Netherlands) and Geneva Law (named for treaty negotiations held over the years at Geneva, Switzerland)."[83] The Hague Conventions were drafted in 1899 and 1907, and the latest Geneva Conventions were drafted in 1949. One alternative may be to create a combatant contractor legal category. Such changes need to address command relationships and disciplinary authority. More important, worldwide approval would be necessary, and such an agreement could take years.

Recommendation

These are three solutions available in order to utilize contractors as UAV combat pilots. The Air Force and DoD need to change their current procedures, which rely on contractors to conduct combat or combat support missions. The *do nothing* and rule change options are not appropriate. The best overall solution is not to use contractors in combat as combatants. Reality, however, requires contractors so the sponsored reserve option needs to be implemented.

Doing nothing is an unacceptable option. As stated earlier, UAV contractor pilots who conduct combat operations could be considered unlawful combatants. Although they will retain POW status if captured, they could be tried for war crimes or other criminal acts. With the recent establishment of the International Criminal Court, these contractors could be persecuted anytime they leave the safe confines of the US protective borders. "Thus, the person sought by the International Criminal Court would be restricted in his or her travels overseas."[84] Contractor UAV pilots who conduct combat operations would be unable to travel internationally without fear of criminal prosecution. Furthermore, chief executive officers of the company employing these contractors may not want their employees labeled war criminals and do not want to soil the company's public image.

The do-nothing option is inappropriate for the contractors, and failure to follow the rules would affect the deployment commander. The Constitution describes—in Article VI, clause 2—how ratified treaties become the law of the land.[85] "The United States is committed to following the Law of Armed Conflict,[86] as are its military commanders and citizens. Furthermore, military commanders have taken an oath in which they have agreed to support and defend the Constitution of the United States. By allowing contractors to conduct combat operations, military commanders are violating this oath, the Law of Armed Conflict, and other treaties that the United States has agreed to abide by. These commanders may be punished within the context of the UCMJ. These same commanders might be tried for lack of command responsibility for directing these contractors to conduct combat operations. This failure to obey the laws of armed conflict also could jeopardize the US leadership position on the world stage, especially if the United States intended to criticize other countries' wartime procedures or any LOAC violations.

The extreme of taking the do-nothing approach is trying to change established military traditions, customs, and laws. These laws, as stated in the Hague and Geneva conventions have, "developed over the centuries through the customs of States"[87] and have withstood the test of time. These rules originally were created to distinguish military personnel from civilians and are just as applicable today as they were in previous wars. Although recent terrorist activities have made conducting military operations difficult, the moral and legal obligations of distinguishing between military members and civilians are still important.

The best solution is to develop and then implement the sponsored reserve plan. A sponsored reserve would alleviate all the problems identified earlier, ranging from deployment spinup to compliance with the Law of Armed Conflict. Military commanders would have the option to select those individuals in the contractor workforce whom they want to train for sponsored reserve duty and assign those individuals to the appropriate mobility positions. By identifying these individuals early in the program, the unit deployment manager could prepare training schedules and stockpile equipment, eliminating all the unknowns that existed with preparing a majority contractor force with minimal notice. "Contractual agreements regarding military training requirements, military performance standards, and mobilization requirements must be explicit to allow the contractor the tools needed for planning and scheduling."[88] If the weapon system the contractors were developing were needed in combat, the sponsored reserve personnel would be recalled as reservists. Since these reservists are part of the military, the deployment commander would have UCMJ authority. All players need to fall under the purview of the UCMJ, where all individuals can be treated fairly and equally.

The DoD would use only those contractors who are willing to participate in this policy. The contractors would be reluctant to turn down potential large government weapon system contracts just because of this policy. Of course, the military would need to find ways to compensate the contractors if they are contractually obligated to support combat operations. It is very unlikely that

The Air Force and DoD need to change their current procedures, which rely on contractors to conduct combat or combat support missions.

a well-paid contractor would be willing to take a significant pay cut to conduct combat operations. The majority of these contractors may have served 20-plus years in the military already, with numerous deployments. Although the contractors who supported the Global Hawk deployments were all volunteers, they were paid in excess of their military counterparts.

The implementation of a sponsored reserve would benefit the Air Force since it would guarantee combat support of a weapon system well before the system is operational or properly manned by the Air Force. A combat deployment should benefit the contractor through the successful demonstration of its product; failure easily could be blamed on system immaturity. Most important, as military members, UAV pilots no longer would be considered unlawful combatants, and deployment commanders would be able to focus on conducting effective combat operations, not legal ramifications.

Conclusions

According to Eliot Cohen, Professor of Strategic Studies at Johns Hopkins University's Nitze School of Advanced International Studies, "The United States may find itself making even greater use of quasimilitary contractors to do a great deal of what looks like military business; for example, flying and maintaining UAVs."[89] The use of contractor UAV pilots raises numerous issues such as predeployment training, combatant status, and command authority. Until the Air Force and the DoD fully address these issues or stop using contractors as UAV combat pilots, the combatant commander needs to understand current regulatory guidance and how it applies to contractors who conduct UAV combat operations and impacts on mission accomplishments. These issues will multiply with the weaponization of UAVs and contractor operators or pilots who conduct weapon deliveries.

Because of the limitations on contractors who conduct combat operations, the Air Force and DoD need to develop better guidelines for properly integrating contractors into combat operations or utilize a sponsored reserved program if it intends to continue using contractors. This method would remove contractors from under the distasteful banner of unlawful combatant, demonstrate the US desire to comply with international laws, and provide the deployment commander with a more functional fighting force. This option would best serve the needs of the US military establishment and contractor force.

Notes

1. UAV pilots are also referred to as operators.
2. Gordon L. Campell, "Contractors on the Battlefield: The Ethics of Paying Civilians to Enter Harm's Way and Requiring Soldiers to Depend upon Them," paper presented at the Joint Services Conference on Professional Ethics 2000, Springfield, Virginia, Jan 00, 1.
3. General Accounting Office (GAO), *DoD Force Mix Issues: Greater Reliance on Civilians in Support Roles Could Provide Significant Benefits*, GAO/NSIAD-95-5 Washington DC: US Government Printing Office, 19 Oct 94, 0:4.3.
4. Kim M. Nelson, "Contractors on the Battlefield: Force Multipliers or Force Dividers," Air Command and Staff College Research Report AU/ACSC/1320/2000-04 Maxwell AFB: Air University, Apr 00, 4.
5. Kathryn McIntire Peters, "Civilians at War," *Government Executive*, Vol 28, No 7, Jul 96: 24.
6. GAO, 1:1.
7. Maj Lisa L. Turner and Maj Lynn G. Norton, "Civilians at the Tip of the Spear," *The Air Force Law Review*, International and Operations Law Edition, Vol 51, Col Bruce T. Brown, et al, eds, Washington DC: US Government Printing Office, 2001: 8.
8. Darleen A. Druyun, Principal Deputy Assistant Secretary of the Air Force, to Program Executive Officers, letter, subject: Transition to a Wartime Posture, 5 Oct 01.
9. Quoted in Donald H. Rumsfeld, "For the Defense," *Boston Globe*, 13 Aug 03, *National Security and Decision-Making Workbook*, Maxwell AFB, Alabama: Air University Press, 2003, 399.
10. "RQ-4A Global Hawk Tier II+HAE UAV," FAS Intelligence Resource Program, [Online] Available: http://www.fas.org/irp/program/collect/global_hawk.htm, 10 Sep 03.
11. Chronology, Operations Enduring Freedom & Noble Eagle: The Air Force Flight Test Center Supports the War on Terrorism, Sep 01-Jul 02, 14.
12. "RQ-4A Global Hawk Tier II+HAE UAV," FAS Intelligence Resource Program.
13. Guidry's interview with David Morrow, Global Vigilance Combine Test Force, 5 Dec 03.
14. "RQ-4A Global Hawk Tier II+HAE UAV," FAS Intelligence Resource Program.
15. Rebecca Grant, "Eyes Wide Open," *Air Force Magazine*, Vol 86, No 11, Nov 03: 40.
16. Adam J. Hebert, Senior Editor, "Global Hawk Led Eyes Over Iraq," *Air Force Magazine,* Vol 86, No 9, Sep 03: 19.
17. Dr James R. Roche, Secretary of Air Force, "Applying UAV Lessons to Transform the Battlefield," remarks, Association of Unmanned Vehicles Systems International, Baltimore, Maryland, 15 Jul 03 [Online] Available: http://www.af.mikl/news/speech/current/ph2003_24.html, 27 Aug 03.
18. AFI 11-2FT, para A23.2.1.2 requires navigators to have an FAA commercial pilot rating to operate UAVs. AFI 11-2FT, Vol 1, *Flight Test Aircrew Training*, 9 May 02, 195.
19. Morrow interview.
20. Jim Garamone, "Rumsfeld Details DoD Goals, Objectives in Testimony: Speeding Up Research, Development, and Acquisition One of Rumsfeld's Five Key Objectives," PM, Jan-Feb 01, 4.
21. Paul Mann, "Against Huge Odds, Faster Arms Acquisition," *Aviation Week & Space Technology*, Vol 154, No 4, Jan 22, 01: 24.
22. Tom Canahuate, "Rumsfeld Promises New DoD Acquisition System," *Spacenews,* 11 Jan 01 [Online] Available: http://www.space.com/news/spaceagencies/rumsfeld_hearing_0101000.html, 4 Dec 03.
23. Wayne M. Johnson and Carl O. Johnson, "The Promise and Perils of Spiral Acquisition: A Practical Approach to Evolutionary Acquisition," *Acquisition Review Quarterly*, Summer 2002, 178.
24. Jim Ross, NASA Dryden Flight Research Center, X-45 photo #EC02 0295-1, 19 Dec 02 [Online] Available: http://www.dfrc.nasa.gov/Gallery/Photo/X-45A/HTML/EC02-0295-1.html.
25. "Boeing/DARPA Demonstrate UCAV Interoperability with Manned Aircraft," Boeing, 26 Mar 03 [Online] Available: http://www.boeing.com/news/releases/2003/q1/nr_030326a.html, 4 Dec 03.
26. Adam Hebert, Senior Editor, "New Horizons for Combat UAVs," *Air Force Magazine*, Vol 86, No, 12 Dec 03, 72.
27. "Boeing/DARPA Demonstrate UCAV Interoperability with Manned Aircraft."
28. Steven M. Yamaguchi and Jason C. Doster, "Reachback: Application for the Global Hawk RQ-4A," paper presented at the 2003 International Test & Evaluation Association ITEA Symposium, Lihue, Hawaii, 19 Nov 03.
29. Rowan Scarborough, "Hovering Spy Plane Helps Rout Iraqis," *The Washington Times*, 3 Apr 03, 1.
30. According to Yamaguchi, "The Reachback concept of operations is depicted in Figure 3. The concept calls for a UAV performing ISR operations in a given OCONUS area of operations. The UAV and its launch-and-recovery element are based at an OCONUS forward operating location for sortie generation. UAV C2 and imagery dissemination is handled by a CONUS-based, mission-control element (MCE) via Ku satellite communications (SATCOM). The reachback terrestrial WAN connection allows wide separation of the MCE and Ku SATCOM uplink and downlink antenna to take advantage of Ku satellite coverage in various parts of the globe."
31. Turner and Norton, 4.
32. *Air Force General Counsel Guidance Document, Deploying with Contractors: Contracting Considerations*, Nov 03, 2.
33. NaVA Warfare Publication NWP 1-14M, *The Commander's Handbook on the Law of NaVA Operations*, FMFM 1-10, COMDTPUB P5800 [Online] Available: http://www.cpf.navy.mil/pages/legal/NWP%201-14?NWP1-14%20COVER.htm, 25 Feb 04, 5.3.
34. International Committee of the Red Cross, Protocols addition to the Geneva Conventions of 12 Aug 49, Geneva: International Committee of the Red Cross, 1977, 30.

35. AFP 110-31, *International Law—The Conduct of Armed Conflict and Air Operations*, 19 Nov 76, 3-2, and International Committee of the Red Cross, International Law Concerning the Conduct of Hostilities Geneva: International Committee of the Red Cross, 1989, 20.
36. AFP 110-31, 3-3.
37. Lawrence J. Delaney, Acting Secretary of the Air Force, memorandum to all major commands, subject: Interim Policy Memorandum—Contractors in the Theater, 8 Feb 01.
38. Guidry's interview with Ed Walby, Northrop Grumman-Ryan Aerospace Corporation, 11 Dec 03.
39. Maj Michael E. Guillory, "Civilianizing the Force: Is the United Sates Crossing the Rubicon," *The Air Force Law Review*, International and Operations Law Edition, Vol 51, ed Col Bruce T. Brown et al, Washington DC: US Government Printing Office, 2001: 114.
40. Knut Ipsen, "Combatants and Noncombatants," *The Handbook of Humanitarian Law in Armed Conflicts*, ed, Dieter Fleck, New York: Oxford University Press Inc, 1995, 68.
41. AFP 110-34, *Commander's Handbook on the Law of Armed Conflict*, 25 Jul 80, 2-2.
42. Guillory, 135.
43. International Committee of the Red Cross, 76-77.
44. Army Field Manual 100-10-2, *Contracting Support on the Battlefield*, 4 Aug 99, F-3.
45. International Committee of the Red Cross, International Law Concerning the Conduct of Hostilities, Geneva: International Committee of the Red Cross, 1989, 22.
46. AFP 110-31, 3-3.
47. The US Supreme Court addressed this issue in Ex Parte Quirin, 317 US 1 1942: By universal agreement and practice, the law of war draws a distinction between the armed forces and the peaceful populations of belligerent nations and also between those who are lawful and unlawful combatants. Lawful combatants are subject to capture and detention as prisoners of war by opposing military forces. Unlawful combatants likewise are subject to trial and punishment by military tribunals for acts, which render their belligerency unlawful. From Maj Michael E. Guillory, 116.
48. Maj Joseph Keeler, "International Agreements and Status of Forces Agreements," lecture, Legally Leading the Fight Elective, Air War College, Maxwell AFB, Alabama, 11 Sep 03.
49. *Ibid.*
50. Guidry conducted the first combat deployment of the RQ-4A in support of Enduring Freedom as the 452d Flight Test Squadron Commander, Edwards AFB. Col Ed Walby led the deployed operations. The 12th Reconnaissance Squadron, Beale AFB, which Guidry also supported, led the second combat deployment.
51. Gen Hal M. Hornburg, Commander, Air Combat Command, to Ninth Air Force Commander, letter, subject: Global Hawk Operations, 26 Nov 01.
52. JP 1-0, *Doctrine for Personnel Support to Joint Operations*, 19 Nov 98, O-1.
53. JP 1-0, O-1.
54. JP1-0, O-2, and Thomas S. Tudor, ed, *Air Force Operations & the Law: A Guide for Air & Space Forces*, Washington DC: US Government Printing Office, 2002, 433.
55. JP 1-0, O-1.
56. Tudor, 430.
57. Message, DTG-072000Z APR 03, HQ USAF Washington DC/XO to all Major Commands, 7 Apr 03.
58. Tudor, 430.
59. Tudor, 432.
60. Department of the Army Regulation 715-9, *Logistics: Contractors Accompanying the Force*, 29 Oct 99, 3-3e.
61. Tudor, 430.
62. Release, Indemnification, and Hold Harmless Agreement and Agreement Not to Sue, Findlaw [Online] Available: http://www.defenselink.mil/news/Feb2003/d20030210embed, 25 Feb 04.
63. David Wood, "Some of Army's Civilian Contractors Are No-Shows in Iraq," Newhouse News Service, 31 Jul 03 [Online] Available: http://www.newhousenews.com/archive/wood080103.html, 10 Sep 03.
64. Jeffrey L. Robb, "Workers Compensation for Defense Contractor Employees Accompanying the Military Forces," *The Air Force Law Review*, Vol 55, ed Thomas L. Strand, et al, Washington DC: US Government Printing Office, 2004.
65. Deployment commanders should contact their base legal office for assistance in the matter.
66. Turner and Norton, 61.
67. Maj Melvin S. Hogan, "Contractors in the Joint Theater: The Need for a Joint Doctrine" unpublished manuscript, on file with the Air Force Judge Advocate General School, 5 Jan 99, 15, in Maj Lisa L. Turner and Maj Lynn G. Norton, 62.
68. Tudor, 433.
69. Turner and Norton, 105.
70. AFI 44-103, *The Air Force Independent Duty Medical Technician Program and Medical Support for Mobile Medical Units/Remote Sites*, 1 Jan 99, 2.7.
71. AFP 10-231, *Federal Civilian Deployment Guide*, 1 Apr 99, 25.
72. JP 4-0, *Doctrine for Logistic Support of Joint Operations*, 6 Apr 00, V-1.
73. Tudor, 431.
74. Kim M. Nelson, 11.
75. Wood.
76. Wood.
77. Tudor, 423.
78. Walby interview.
79. JP 1-02, *DoD Dictionary of Military and Associated Terms*, 12 Apr 01, as amended through 17 Dec 03, 461.
80. Air Force Directorate of Strategic Planning, Sponsored Reserve Test Implementation Plan, Analytical Support to Air Force Strategic Planning, Washington DC: Science Applications International Corporation Center for Total Force Analysis, 2001, 4.
81. These issues are too numerous to discuss and would distract from the overall purpose of this article. For a complete review of these issues, reference Air Force Directorate of Strategic Planning, Sponsored Reserve Test Implementation Plan, Analytical Support to Air Force Strategic Planning, Washington DC: Science Applications International Corporation Center for Total Force Analysis, 2001
82. Bo Joyner, "The Future Total Force," *Citizen Airmen*, Apr 01 [Online] Available: http://www.au.af.mil/au/awc/awcgate/readings/ftf/future.htm, 24 Feb 04.
83. Thomas L. Strand, ed, *The Military Commander and the Law,* Washington DC: US Government Printing Office, 2002, 539.
84. Capt Andrew S. Williams, "The Proposed International Criminal Court: An Imminent Danger?" *Reporter*, Vol 27, Issue 2, Jun 00: 3-7.
85. Commission on the Bicentennial of the United States Constitution, The Constitution of the United States, Washington DC: DoD, 1991, 15.
86. Chairman of the Joint Chiefs of Staff Instruction 5810.01B, *Implementation of the DoD Law of War Program*, 25 Mar 02, 1.
87. International Committee of the Red Cross, 1989, 8.
88. Sponsored Reserve Test Implementation Plan, Analytical Support to Air Force Strategic Planning, 8.
89. Eliot A. Cohen, "A Tale of Two Secretaries," *Foreign Affairs*, Vol 81, No 3, May-Jun 02: 33-47.

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notable quotes

Knowledge of grand tactics is gained only by experience and by the study of the campaigns of all the great captains.

—Napoleon

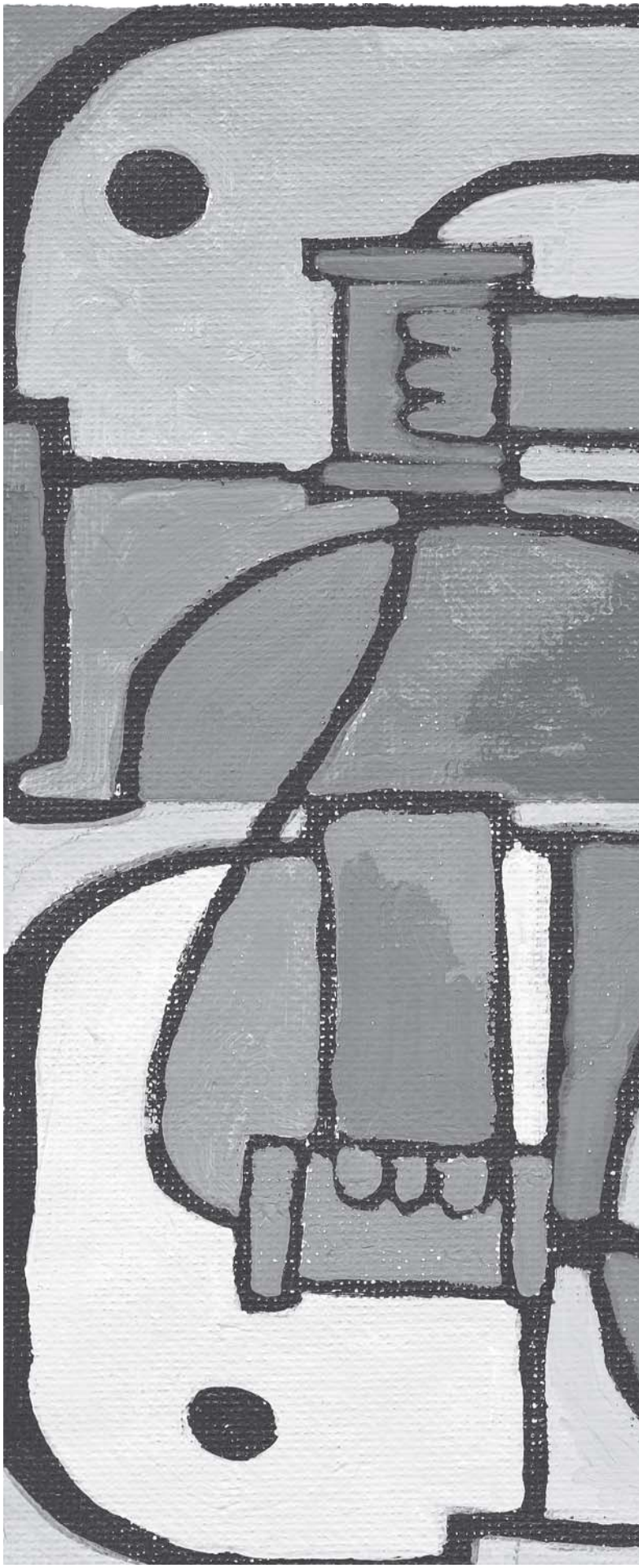
Introduction

Special Feature

The Department of Defense (DoD) is in the process of transforming the Army, Navy, Marines, and Air Force into leaner and lighter warfighters to prepare for a myriad of challenges that may face the United States in the years to come. Along with these changes to its military forces, the DoD is designing, developing, and incorporating the necessary capabilities to enhance its logistics support systems so that it can ensure the timely sustainment of its transforming fighting forces. For logisticians, the requirement to provide timely support to the warfighters means the DoD's logistics supply chain will need to transform the tools it uses to support all the military services.

Radio frequency identification (RFID) is a Logistics Transformation tool the DoD can use to provide valuable insight into the DoD supply chain and ensure the United States that leaner and lighter military forces are combat-ready when required to protect the country's national interest. The valuable insight that RFID technology can provide is termed Total Asset Visibility (TAV). Total Asset Visibility is envisioned in the DoD's Joint Vision JV 2020 plan and Joint Chiefs of Staff (JCS) Focused Logistics concept as a capability that can enable the DoD to transform the military into lighter and leaner force packages for future conflicts. RFID technology provides DoD logisticians the capability to identify, categorize, and locate assets automatically. As users of TAV information, US Transportation Command (TRANSCOM), Air Mobility Command (AMC), and the warfighting combatant commanders can benefit significantly from RFID technology, because RFID can provide insight into the movement of cargo during major theater war and contingency operations. At the same time, the Defense Logistics Agency (DLA), the organization responsible for integrating RFID capabilities within the DoD, can benefit financially by integrating RFID technology to lower the quantity of its sizable inventory.

RFID technology used within the DoD today has been very beneficial. However, because RFID is a fairly new technology, the current DoD RFID system is obsolete, and RFID industry wide is nonstandard and noninteroperable. To meet the myriad of challenges that may face the United States in the future, today's RFID technology shortfalls must be corrected. Like the DoD, the commercial industry has learned the benefits of using RFID technology and is using it throughout supply chains to automate inventory and for movement of items. So the question is, can the DoD benefit from commercial industry's pursuing RFID technology to correct current RFID technological shortfalls?



RFID Technology

Is the Capability a Boon or Burden for DoD?

Lieutenant Colonel Howard C. Davis, USAF
Colonel Steven R. Jones, USAF

RFID and DoD's Transformation

If we do not change the direction we are going, we will end up where we are going.

—Chinese Proverb

The end of the Cold War forced the Armed Forces to institute a tremendous change in the country's National Security Strategy. After years of having an identifiable and quantifiable threat, the DoD's post-Cold War military strategy drove the Armed Forces to become smaller and more mobile. In light of these changes and as a result of lessons learned during military operations since the end of the Cold War, future US military operations will employ a smaller, highly mobile armed force that will face an uncertain enemy. World changes have forced the development of a more flexible National Security Strategy, and each of the Services within the DoD is posturing to predict the right mix of combat capabilities for an uncertain future.

The DoD has termed the transition to the right mix of military capabilities as *transformation*. This transformation has been defined by the Air Force as:

> ...a process by which the military achieves and maintains advantage through changes in operational concepts, organization structure, and/or technologies that significantly improve its warfighting capabilities or ability to meet the demands of a changing security environment.[1]

Even if the individual military services manage to hit upon the correct capabilities and combat mix—the right transformation concepts—there remains a single challenge that will affect mission success for the entire DoD in future military operations. That challenge lies in the performance of the DoD's logistics support systems.

To ensure successful logistics support in future military operations, the DoD developed the JV 2020 plan, which is intended to be the DoD strategy that will guide the movement of the Armed Forces into the uncertain future. Prior to JV 2020, a number of today's Cold War-era logistics systems were developed to provide support against a known and predictable threat. These archaic systems were designed to depend on large quantities of supplies and equipment being stockpiled in an overseas location. These locations were well-known by the warfighters and were in locations where training had taken place. In today's post-Cold War environment, the logistics support systems of the past have to be modified. The DoD's logistics support strategy must include forward basing with the right amount of supplies and equipment, which means no under or over supply.

The real challenge for the DoD is to improve the logistics support capabilities for its smaller, mobile, and joint forces that will be required to engage in missions around the world. Ultimately, the DoD will employ one of the six concepts of JV 2020, Focused Logistics, to guide the Armed Forces to logistics support improvements.[2] Focused Logistics as defined by the JCS-J4 Logistics Directorate is:

> ...the fusion of information, logistics, and transportation technologies to provide rapid crisis response, to track and shift assets even while en route, and to deliver tailored logistics packages and sustainment directly at the strategic, operational, and tactical levels of operations.[3]

The ultimate goal of the Focused Logistics concept is to provide an umbrella of logistics capabilities to guide the transformation of the Armed Forces into the future. Given the Focused Logistics concept is the logistician's guide for the future, it is important to identify the subconcepts that link RFID technology capabilities to the future vision of logistics sustainment.

As a supporting document to the Focused Logistics concept from the JCS, the Focused Logistics campaign plan was developed to address how the DoD should transform its logistics sustainment systems, processes, and organizations to support the warfighting combatant commanders in future military operations.[4] In essence, the Focused Logistics campaign plan articulates how logisticians and operators can work as partners to provide the military fighting forces the capabilities and benefits of Focused Logistics. Within the campaign plan, Logistics Transformation is identified as a building block that will help lay the foundation for the Focused Logistics concept to succeed.[5] The plan suggests that the transformation of logistics has started already and that the foundation that establishes the capabilities of Focused Logistics rests on a pillar that provides DoD senior leaders a view into the logistics sustainment system; that pillar is Total Asset Visibility. Total Asset Visibility is envisioned to provide logisticians visibility into all assets in the logistics support process—those either being acquired or in maintenance, storage, or transit.[6] Total Asset Visibility is an initiative that can provide future joint warfighters real-time, logistics situational awareness.

As an enabler of Total Asset Visibility, automatic identification technology (AIT) is a mechanism that can be used at critical nodes in the logistics supply chain to provide efficient and effective logistics data collection. AIT is the name given to devices used to automate data collection. The goal of AIT is to provide cost savings within the logistics support process by using automated means to collect logistics data. The Air Force AIT vision states:

> The Air Force should have accurate and timely information available to decisionmakers in 2005, whether Air Force, joint, or coalition—through the exploitation of AIT-capable information systems where source data are captured at the home base, so that deployed forces will no longer have to accomplish data collection manually.[7]

To sum it up, AIT is a mechanism that will help the DoD logistics community achieve the Focused Logistics

World changes have forced the development of a more flexible National Security Strategy, and each of the Services within the DoD is posturing to predict the right mix of combat capabilities for an uncertain future.

concept TAV objective—total visibility into the logistics support process.

As the Focused Logistics campaign plan mentions, AIT is critical to Logistics Transformation, and the need to ensure integration of the supply chain is one of the key functions required to shape the future logistics environment.[8] Supply chain integration is a task that falls under the main task of Supply Chain Management (SCM), which covers all actions accomplished throughout the supply chain. SCM is defined in the *DoD Supply Chain Management Implementation Guide* as:

> ...an integrated process that begins with planning the acquisition of customer-driven requirements for material and services and ends with the delivery of material to the operational customer, including the material returns segment of the process, and the flow of required information in both directions among suppliers, logistics managers, and customers.[9]

Commercially, a supply chain is defined as, "An association of customers and suppliers who, working together yet in their own best interests, buy, convert, distribute, and sell goods and services among themselves, resulting in the creation of a specific product"[10] Merging the definitions to the lowest level, SCM is the means of integrating the activities of the supply chain to optimize cost and performance and reduce the time between ordering and delivering a product.

The reason RFID technology is key to SCM and Total Asset Visibility is that RFID technology can be used as an AIT tool, an *enabler*, a means to carry and retrieve data by electronic means, and to identify items in manufacture, in transit, and at locations.[11] RFID technology can provide logisticians the capability to identify, categorize, and locate assets automatically throughout the DoD's logistics supply chain. RFID can provide a capability that has been termed in the DoD as intransit visibility (ITV). RFID technology is a key to the DoD's Logistics Transformation efforts, because enabling RFID technology can ensure the Focused Logistics concept and the JCS JV 2020 plan for the future become a reality within the DoD. RFID technology is critical to current and future military operations because, in the best case, logisticians will be able to tell that the supplies are where they are required, and in the worst case, if the supplies are not where they are supposed to be, logisticians will know where they are.

RFID in the DoD Supply Chain

> *We are witnessing a revolution in the technology of war, power is increasingly defined not by size but by mobility and swiftness—influence is measured in information....*
>
> **—Governor George W. Bush**

It is important to understand how RFID technology is linked to the DoD's plan for transforming its forces and logistics support systems, and it is equally important to understand the types and capabilities of RFID technology. RFID technology offers a fairly new approach to collecting information, by providing the capability to identify, categorize, and locate people and assets automatically over short and long distances. An older and, maybe, more familiar approach to an electronic information collection system is the universal product code (UPC) or bar code. UPCs and bar codes have been around since the 1970s, but the technology is limited. It only has a capability to store 17-20 characters of data.

Article Highlights

The DoD should harness the capabilities of RFID to ensure its logistics sustainment systems will be able to support its transforming military forces.

To sustain the US military's lighter and leaner warfighters, logisticians are planning to integrate capabilities into the DoD's supply chain that will provide asset visibility, while at the same time provide financial savings. RFID technology is a capability that can ensure the fighting forces will be efficiently sustained during the myriad of challenges that may face warfighters in the future. Integrating RFID technology can provide warfighters and logisticians total asset visibility into the DoD's supply chain and afford the DoD substantial savings by reducing its sustainment inventory. RFID capabilities should not be looked at as just another so *what—sounds good* idea that will burden combat operations. Ultimately, the capabilities provided by RFID technology will benefit the entire DoD.

Figure 1. Linear Bar Code

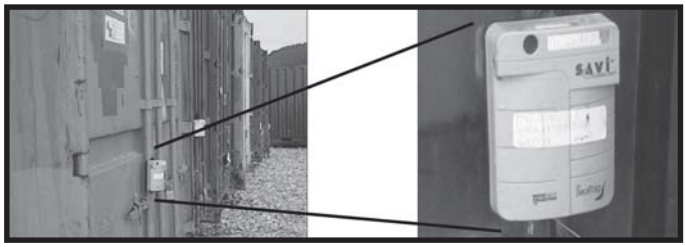


Figure 2. Active RFID Tag (Tag Attached to a Storage Container and Tag Close Up)

Figure 3. Portable RFID Reader and Active RFID Tag

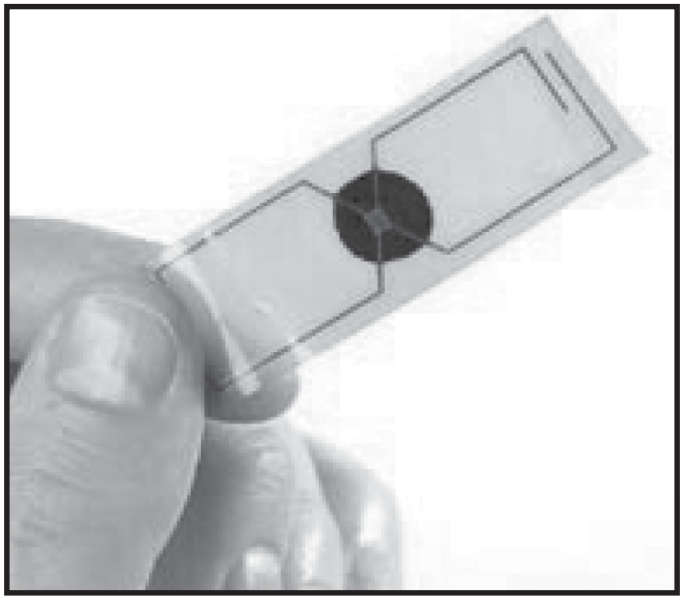


Figure 4. Passive RFID Tag

Additionally, bar codes require scanning, which means they require line-of-sight access for optical recognition (Figure 1).[12]

RFID technology uses radio frequency (RF) communications to transmit and receive data, and the technology is based on the ability to collect, store, and retrieve data remotely on a tag using RF communications. RFID technology is based on an electronic product code (EPC), "a 96-bit code that is capable of identifying more that 80 thousand trillion, trillion-unique items."[13] There are two parts to the RFID data collection system, a tag and a reader. RFID tags can have one or several memory chips for data storage, a circuit board structure for its electronic components, and an antenna to send and receive information using RF communication capabilities.[14] Tags can range in size from that of a grain of rice to that of a brick. As the second part of the RFID data collection system, the RFID reader communicates with RFID tags using RF energy. The RFID reader uses an RF signal to initialize the tag, and the tag then transmits information back to the reader using RF energy. The reader also can write information on the tag. Written information can range from as little as a serial number to kilobytes of data both written to and read from the tag.[15] Information from the tag, after being read, can be presented to a human operator using a handheld device with an alphanumeric display, or the information can be entered into a larger computer system that provides data management for a large organization.

The types of RFID tags can vary. They can be active (Figures 2 and 3) or passive (Figures 4 and 5), which refers to the method of powering the tag. While both active and passive tags use RF energy to communicate with the reader, the technology of powering the tags and capabilities of each of the tags is quite different. With respect to power, active RFID tags use an internal power source to continuously power the tag and its RF communications circuitry. On the other hand, passive RFID tags rely on RF energy being transferred to the tag from a reader and the reader's power then providing the capability to read or write data. Capabilities for each of the tags vary in communication range, the amount of data storage, and in the tag's capabilities to monitor and record specific parameters. Active tags can be read at ranges up to 100 meters and at speeds in excess of 100 miles per hour. They have the capability to store a minimum of 128,000 bytes, 1 million bits of dynamically searchable read-and-write data, and because active tags are constantly powered, they have the ability to detect a parameters condition continuously. Parameters can include temperature, vibration, and security status, to name a few. [16] Passive tags can be read at a range of 3 meters or less and at speeds up to 3 miles per hour. They typically have the capability to store a maximum of 128 bytes, 1,000 bits of read-and-write data. They do not have a data search or manipulation capability, and because passive tags are not powered by a battery, they are unable to detect parameters.[17] One of the biggest differences in the two tags is that active tags have a limited life cycle because of their internal battery, while passive tags have a virtually unlimited life.

The DoD's supply chain can benefit from both active and passive RFID to enhance supply chain visibility. However, because of the technological differences between the two types, there are benefits of using one type over the other. Active RFID is best suited for dynamic business processes, where the movement of tagged assets is variable and sensing and increased data storage capabilities are required. Passive RFID is best suited

for use with items where the movement will be fairly consistent and controlled and minimal data storage capability is required.[18]

Within a supply chain, either active or passive technologies can prove beneficial, and in some cases, the use of both types of RFID can be of benefit. For example, using RFID technology, it is possible to embed a passive RFID tag into a manufactured item and have the tag read and written to during the manufacturing process to gather and exchange work process data. The same tag then could be read or written to by shipping personnel at the manufacturer's shipping dock in order to release the item from the manufacturer's inventory. While at the shipping dock, the item's planned route information could be written onto the item's tag and read by a reader that enters the item's information into a company's management information system for a variety of purposes, including logging the item's manufacturing data or tracking the item's cost to build or current location. Prior to a large number of items being shipped, information for each item can be written to an active RFID tag that is placed on a shipping container or pallet. The recipient of the containerized or palletized items can be aware of the current location of the items at all times, using a management information system, and the item's location can be updated while in transit as the active RFID tag passes nodes along the transportation route, which are linked to an automatically updated information system database. The preceding scenario provides a simple example of how RFID technology can be used; now it is important to understand how the DoD actually is using RFID technology, the plan for future use of RFID technology, and the challenges that exist in the RFID technology arena.

The DoD's supply chain can benefit from both active and passive RFID to enhance supply chain visibility.

Analysis

In the 21st century, technology will make it possible to find, fix or track, and target anything that moves on the surface of the earth.

—General Ronald R. Fogleman, USAF

Current Use

When General Fogleman, former Chief of Staff of the Air Force, made the statement above, he was referring to the ability of the Services' combat forces to engage an enemy's force anywhere on the surface of the earth by using advanced information technology. A similar hypothesis is envisioned by logisticians—using technology to find, fix, track, and target anything that moves within the DoD's supply chain. The Persian Gulf War has been called the impetus behind the use of RFID technology in the DoD.[19] There are two experiences from the Gulf War that drove the logistics community to recognize the need for RFID technology and, finally, implement its capabilities.

The first experience occurred because US military forces were plagued by several logistics inefficiencies during the Gulf War. As the head logistician during the war, Lieutenant General William Pagonis acknowledged that knowing what was in shipping containers proved to be problematic.

> Intheater processing of containers also presented a major headache, for a number of reasons. One big contributing factor was multiple consignees for a single container. This resulted from the eagerness of our stateside, European, and Korean shippers to fill every container to the brim, which would ensure every ship was filled to capacity. Given our limited shipping capacity, this made good sense—at least until those ships disgorged their cargoes in Saudi Arabia. Then it turned into a classic example of suboptimization.[20]

Figure 5. Passive RFID Memory Button

As a result, during the Gulf War, the United States shipped approximately 40,000 containers of supplies and equipment to support military operations. Throughout the war, these containers, which contained everything from food to ammunition, amassed on the docks of the Saudi Arabian port. Since receiving personnel could not determine what was in them, they had to be opened and inventoried prior to distribution. This resulted in a bottleneck in distribution. As Pagonis points out:

> We had numerous mixed loads and even a larger number of unidentified containers. The documentation on the ship's manifest didn't always jibe with what was in the containers. We had to open some 28,000 of the 41,000 arriving containers right there on the docks just to find out what was in them. We hauled a lot of containers 2,000 miles out into the desert only to find that 10 percent of their contents were intended for the front-line troops, whereas 90 percent belonged to units back near the port.[21]

Because the supply system was not able to get supplies and equipment to units when needed, supply personnel began ordering more of what was needed, hoping that a reordered item might make its way to the unit; as a result, multiple items clogged the supply lines even more.[22] By the end of the Gulf War, "8,000 containers stood on the docks unopened. No one knew what was in them or whom they belonged to."[23]

The second experience occurred because the short duration of the Gulf War created large stockpiles of unused ammunition. Following the end of the war, the United States had a huge stockpile of *live* weapons located in Saudi Arabia, "We had something like 250,000 tons of ammunition sitting there in the desert, waiting to be packed and sent home."[24] The large numbers of unopened shipping containers from the first experience made logisticians take notice of the considerable problem the DoD had with ITV. In the case of the shipping containers, they could be returned to the point of origin; however, in the case of the large quantities of palletized ammunition, the Army had to redeploy and keep track of the valuable assets movement throughout the

DoD's supply chain. To provide ITV of the retrograde ammunition from the Gulf War through Europe, the Army first began using active RFID tags in late 1991 and early 1992.[25] After the retrograde of the Gulf War ammunition proved successful using RFID tags, the US Army Strategic Logistics Agency (now the Army Logistics Transportation Agency [LTA]) requested the DLA conduct a test to identify an active RFID tag the Army could use to track certain Class IX repair parts, shipped to and from designated overseas customers.[26] Beginning with its use in 1991-1992 and since the DLA test in 1993, the Army has pursued the long-term use of active RFID tags. In an agreement with DLA, the Army procured and furnished active RFID tags to DLA so that tags could be affixed to Army pallets and containers for exercises, contingency operations, and routine shipments. In the scenario, the Army LTA owned most of the DoD's RFID technology assets, which included stationary and handheld readers and writers, tags, magnetic mounting brackets, and remote ITV servers.[27] Fourteen of DLA's distribution sites were instrumented to store data and generate software for active RFID tags for Army shipments; and DLA's biggest container consolidation points at New Cumberland, Pennsylvania, and San Joaquin, California, were outfitted to tag consolidated DoD shipments headed for Europe, Central Asia, the Middle East, and the Pacific.[28]

Now, with an understanding of why the DoD began using RFID technology and who manages RFID within the DoD, it is important to point out how the DoD is using RFID technology. Twelve years after experiencing the severe supply inefficiencies of the Gulf War, the DoD is using active RFID tags to achieve ITV of assets throughout the supply chain. RFID technology has been installed around the world by the DoD to determine the location of containers and pallets and provide supply chain visibility into the contents of items intransit. RFID readers are located at airports, airfields, distribution centers, assembly areas—these nodes have been established throughout the world to read active RFID tags attached to DoD pallets and containers. RFID readers at the various nodes in the supply chain *read* the active tags and transmit the information to local ITV servers. These local servers provide database storage and transmit the collected data to centralized regional servers.[33] Currently, regional servers are located in the European Command, Pacific Command, and CENTCOM; these servers are connected to a national ITV server in the United States, which acts as a data source for the DoD's global asset visibility system called Joint Total Asset Visibility (JTAV). For transmission of data from remote locations without local or regional connectivity, logisticians can use Iridium satellite terminals as modems to relay the pallet and container data to the national ITV server.[34] JTAV is linked to another DoD system, the Global Transportation Network (GTN); both JTAV and GTN are available to DoD personnel who use the World Wide Web to track and determine an item's location.[35]

RFID is a relatively new automatic data-collection system, and like many computer technology-based systems, the technology is changing rapidly.

Fast forwarding to 31 July 2002, the combatant commander of US Central Command (CENTCOM) directed that all containerized shipments being sent to the CENTCOM area of responsibility be RFID tagged.[29] As a direct result of the commander's decision, the DoD had the ability to track all support items shipped on pallets and in containers to the area of responsibility. As an indirect result of the decision, the need for RFID tags increased significantly. To meet the need, the Army initially increased the number of active RFID tags purchased to cover the additional Operation Enduring Freedom requirements. Then, at the beginning of Operation Iraqi Freedom, CENTCOM issued a requirement that all containers and pallets sent to CENTCOM's area of responsibility in support of Enduring Freedom and Iraqi Freedom be RFID tagged—regardless of the service.[30] The Army realized the significant increase in RFID required to meet this new requirement, and in February 2003, the Army went on record to request it not be held responsible for providing RFID tags to all the Services. Additionally, the Army asked DoD to recommend a solution to resolve the active RFID-tagging problem.[31] DLA was and still is identified as the office with management responsibility for RFID technology within the DoD. As a result, DLA selected the standard active RFID tag for use in the DoD and put wholesale management in place to control the purchase, issue, and refurbishment of the standard tags.[32]

The following scenario is provided to describe how active RFID capabilities are used when items are shipped within the DoD. Items being shipped in containers and on pallets are recorded on an active RFID tag, and the tag is placed on the outside of the shipping container or on the pallet. Simultaneously, the item's information stored on the RFID tag is sent to an ITV server to enable shipment tracking. As the RFID tag passes through various transportation nodes, ground-based or handheld readers collect the tag's information; this information is downloaded automatically; and the tag's ID, location, and date-time group are forwarded to the national ITV server to report the tag's current location.[36] RFID technology provides the DoD and ITV capability now, and these capabilities are a step in the right direction in correcting past supply problem inefficiencies. RFID technology is currently in use, and the DoD has a plan to utilize even more RFID capabilities to enhance the DoD's logistics capabilities.

Future Use

A recent presentation by the JCS Directorate of Logistics identified RFID technology as a key logistics ITV enabler of Iraqi Freedom.[37] The CENTCOM-mandated ITV RFID capability gave

the DoD the capability to track food, spare parts, vehicles, medical supplies, ammunition, and construction materials, and "ground-based readers provided near real-time ITV of contents on ships, trains, aircraft, convoys, and commercial trucks, and satellite-enabled tracking systems provided logisticians visibility on items to the last tactical mile."[38] During Iraqi Freedom, there were between 50,000 and 60,000 US and UK pallets and containers tracked monthly using active RFID and more than 500 ground-based nodes that could read and write active RFID data in the CENTCOM area of responsibility. Worldwide, it is estimated the DoD's current RFID network manages and monitors 270,000 cargo containers transporting military supplies through 400 locations in more than 40 countries.[39]

Even though the DoD's use of RFID technology significantly increased between the Gulf War and Iraqi Freedom, the DoD is not satisfied with the results. On 2 October 2003, the Under Secretary of Defense for Acquisition, Technology and Logistics (USD AT&L) issued a policy letter to describe how the DoD will pursue active and passive RFID in the future. The letter initiated the strategy that integrates RFID technology use throughout the DoD. The policy and accompanying strategy is in five parts.

- The policy directs the continued use of active RFID tags to support ongoing combatant commander ITV requirements and operations.
- The policy requires DoD suppliers to put passive RFID tags on the lowest possible piece or part, case, or pallet packaging.
- The policy directs that DoD components establish an initial capability to read passive RFID tags at key sites in preparation for passive RFID implementation.
- The strategy establishes a DoD RFID integrated product team and directs the team to achieve five goals:
  - Evaluate and inform the applicable DoD components of RFID standards.
  - Implement initial RFID projects to demonstrate possible technical applications.
  - Conduct an RFID summit to solicit comments on the policy from suppliers.
  - Complete an analysis on the initial projects to identify lessons learned.
  - Provide a final RFID policy and strategy to the DoD.
- The letter describes implementation and integration of the first four parts as critical elements for the future success of systems development across the DoD. However, USD AT&L does not provide any additional funding. USD AT&L suggests the DoD components consider these RFID requirements in their near-term budget adjustments and in their long-term requirements when developing upcoming service and agency budgets.[40]

The USD AT&L policy letter goes a step further and identifies six layers or supply chain item movement locations, where the DoD expects to use RFID tracking in the future. The layers include:

- Layer 5—the movement vehicle truck, aircraft, ship, or train
- Layer 4—the freight container 20- or 40-foot container or 463L pallet
- Layer 3—unit-loaded assets warehouse pallets, fiberboard packaging
- Layer 2 – the transport unit carton, boxes
- Layer 1—in bubble packs
- Layer 0—at the product item

DoD's goal is to use RFID technology to track items at each layer.[41] Additionally, the USD AT&L letter identifies and directs DoD organizations that are responsible for providing the warfighting combatant commanders active RFID support. First, TRANSCOM was directed to ensure US and overseas aerial and seaports, both military and commercial, that support military operations have the necessary equipment to meet the RFID read-and-write requirements. Second, the USD AT&L identified the specific military departments responsible for ensuring sufficient RFID equipment is available to support each of the combatant commander's military plans and operations.

Although it is not mentioned in the USD AT&L policy letter, DLA, as the responsible organization for RFID technology within the DoD, is pursuing technologies to further integrate RFID capabilities into the DoD's global ITV network. DLA is working with industry to develop the strategies and capabilities to enhance the DoD's supply chain infrastructure; this effort is ongoing at DLA via a program called Microchip Logistics (MICLOG). The goal of MICLOG is to integrate active and passive RFID technologies into DLA's RFID management structure. Once MICLOG is implemented, DLA is expected to have insight into item movement down to Layer 0.[42] Additionally, DLA hopes that private sector business practices will demonstrate the real impact of using RFID technology. A study by the global consulting firm Accenture concluded that RFID technology can lower inventories by at least 5 percent, to as much as 30 percent.[43] RFID could have a major impact on DLA's immense logistics enterprise. DLA manages 4.6 million items, processes 30,000 requisitions daily, and has an inventory valued at $80.5B.[44] Using Accenture's 5-percent estimate, DLA can expect to save more than $4B against its $80.5B inventory. If DLA can reduce its inventory by 30 percent, its savings could be more than $24B.

The newly minted policy from USD AT&L makes it clear the DoD is committed to incorporating both active and passive RFID technology into its global supply chain as quickly as possible, and as the policy letter states, implementation of RFID is critical if the DoD's Logistics Transformation is to occur.[45] And with $4B to $24B in possible savings, DLA stands to benefit tremendously from RFID technology. As the DoD and DLA prepare to move forward with incorporating RFID technology in the future, there are challenges that must be addressed to make RFID capabilities a reality for the DoD in the future.

Challenges

RFID is a relatively new automatic data-collection system, and like many computer technology-based systems, the technology is changing rapidly. Although RFID technology is a powerful data-collection tool, the DoD needs to recognize that, like all great ideas, there are challenges that must be met before the technological benefits can be recognized. Obsolescence, standardization, and interoperability are all critical challenges that affect the DoD's use of RFID technology; currently, all three issues have an effect on DoD's RFID technology implementation. Since the end of the Gulf War in 1992, RFID technology has

benefited the DoD tremendously. Because of these benefits, the DoD intends to capitalize on RFID technology and implement the technology in the DoD supply chain.

The DoD's current fleet of active RFID tags provides logisticians valuable insight into the global DoD supply chain. However, RFID, like most electronic systems, has a short technological life cycle, so the decision to purchase a system today can mean that you have an obsolete system within a few months. Currently, the DoD's active RFID tags have the capability to log and transmit logistics data as required in today's supply chain; however, since DLA made the decision to procure the standard active RFID tags, industry has developed additional capabilities that could prove beneficial to the DoD. The North River Consulting Group (NRCG) recently provided the Federal Highway Commission a report that identifies active RFID tag capabilities that are becoming available to freight transporters.[46] Since 1991, the railroad industry has been investigating automatic data-collection technologies that can enhance freight security and productivity.[47] Three of the technologies mentioned in the NRCG report can enhance the way the DoD uses active RFID tags to track an item's location and could prove beneficial to the DoD by incorporating the capabilities into the supply chain. The report indicates that active RFID tags that can sense temperature changes, detect vibrations, and monitor security breeches are *in the works*.[48] Tags that can monitor temperature changes could prove useful in establishing an audit trail and assigning liability for temperature sensitive cargo. Likewise, having an active RFID tag that can detect vibration if a pallet or container is dropped by a shipper or determine if a cargo container is opened while in transit could prove to be an invaluable tool for DoD supply chain ITV. It is apparent that active RFID technology capabilities have improved significantly since DLA made the decision to procure the DoD's standard active RFID tag, and it is possible that these new capabilities can be integrated into current active RFID tag capabilities to address the obsolescence in technology found in today's DoD active RFID tags that only provide item location updates. It is possible these new capabilities could be incorporated into the DoD's supply chain to provide valuable ITV information

Even with the new active RFID capabilities, there are two major challenges associated with RFID technology that must be addressed before widespread use of the technology takes hold. The lack of RFID frequency standardization and interoperability problems associated with RFID readers and tags from different vendors are two challenges that are slowing RFID growth worldwide.[49] With respect to frequency standardization, most RFID vendors offer proprietary systems, which results in RFID frequencies' being selected for tags based on a vendor's preference. With a host of vendors, the state of RFID frequencies is in disarray because there is no one standard; the systems that exist for rail, truck, air traffic control, and tolling authorities can all be—and most are—on different frequencies.[50] The lack of frequency standardization is a global challenge, and frequency regulatory differences between countries are pretty much nonexistent. As a result, there is no single frequency available for logistics applications across the major theaters of Asia, Europe, and North America.[51] With regard to interoperability between RFID tags with tag readers, currently, there is no universal standard for reading encoded information from active or passive RFID tags or a standard for encoding tags. As a result, problems develop when vendors build RFID tag readers. Vendors easily can design readers for their specific tag; however, organizations like the DoD then would be limited to a sole supplier for all RFID applications. With a multitude of global vendors supplying RFID technology, the scenario of procuring various vendors single source technology will not work in the real world.

As an example, these nonstandard and noninteroperable RFID technology challenges could have an effect on the DoD's ability to conduct successful US-only and multicountry coalition military operations in the future. During Iraqi Freedom, the UK's decision to procure the same active RFID capabilities as the United States paid off big.

The lack of frequency standardization is a global challenge, and frequency regulatory differences between countries is pretty much nonexistent.

> They decided to implement the same RFID technology that the United States is using.... They had an incident where they could not find a tank track that had been ordered. So they made plans to place a second order, but someone suggested trying to find it with the ITV system. They found it, and it saved them about $3M in cost avoidance.[52]

Because the United States and United Kingdom fought as a close-knit coalition during Iraqi Freedom, the decision to procure a similar RFID system probably was easier than most coalition decisions. But the scenario raises the question: in the future, will the US coalition partners pursue the same RFID technology as the United States? The US coalition partners' decision on RFID technology, like major weapon systems they purchase, most likely will be driven by how the DoD proceeds with RFID. With common US and coalition military systems, like the F-35 joint strike fighter, where multiple countries will use the same airframe and where parts are manufactured and shipped from global sources, it is possible that, during future military operations, the United States or a coalition country will need a part from the other's *parts bin* to make an aircraft mission capable. To make an aircraft mission ready quickly, a possible scenario might be for a US logistician to request a coalition partner to look in its ITV system to determine if it has a needed part in the supply chain headed for the area of operations. Without RFID

standardization and interoperability, this scenario would be a dismal failure. The only way for the DoD to ensure that its vendors, parts suppliers, and global coalition partners all have the same RFID capability to encode and read active and passive RFID is to work toward universal frequency standards and interoperability between RFID readers and tags.

Recommendations

Information technology is a key enabler for managing the Defense Department's vast transportation continuum and is the linchpin for defense logistics distribution in peace and war.

—General John W. Handy, USAF

It is important to examine the next step the DoD should take in pursuing active RFID and how the DoD should proceed in addressing the challenges of active and passive RFID standardization and interoperability. A recommendation for how the DoD should proceed with integrating RFID technology will be presented after evaluating three alternative options. Each option identifies both negative and positive impacts the DoD will experience if the course of action is selected (Table 1).

Option 1

The DoD should continue with its present plan to integrate passive RFID technology into the supply chain and continue to use its current active RFID technology. A negative impact to this approach is the DoD cannot be sure the nonstandard and noninteroperable challenges affecting passive and active RFID technology will be corrected in time for its implementation in January 2005. Furthermore, by not implementing new active RFID capabilities, the DoD will not be able to benefit from the advanced technologies that are available. A positive impact to this approach is that guidance already has been distributed to the appropriate organizations within the DoD and to its suppliers on the plan to implement passive RFID. As a result, the DoD is on its way to implementing a passive RFID capability in 2005. Additionally, the active RFID technology in use within the DoD's supply chain has been successful in providing item tracking at the container and pallet levels. If the DoD does not implement new active RFID capabilities, the capabilities that exist still would be beneficial.

Option 2

The DoD should continue with its present plan to integrate passive RFID technology into the supply chain and move forward with acquiring new active RFID technology. As with Option 1, a negative impact to this approach is the DoD cannot be sure the nonstandard and noninteroperable challenges affecting RFID technology will be corrected in time for implementation of passive or new active RFID capabilities. A positive impact to this approach is that the DoD can incorporate enhanced active RFID capabilities to build smarter supply chains. New active RFID technology is available to be incorporated into the DoD's supply chain. Temperature sensing, vibration detection, and security monitoring can provide significant insight into and productivity gains to the DoD's supply chain, and the new capabilities can be integrated into active RFID tags to address obsolescence.

Option 3

The DoD should move ahead slowly with integrating passive RFID technology and new active RFID technology into its supply chain. Using this approach, current active and passive RFID standardization and interoperability challenges can continue to be addressed and a solution found. To date, a consortium of 87 global companies and 3 research universities has joined in a partnership with the Uniform Code Council and European Article Numbering International to address RFID challenges and develop global RFID standards.[53] The consortium, known as the Auto-ID Center, is developing international RFID standards for infrastructure, data formats, and frequencies.[54] The center was developed by visionaries who are intent on keeping the individual companies from spending millions of dollars to develop new RFID technology by having all the companies invest in the development of new RFID, with the hope the global community accepts the center's technology as the industry standard.[55] To ensure savings for all, the Auto-ID Center's research has support from global manufacturers and retailers so that companies worldwide can be assured the final RFID products developed by the center will be standard and interoperable. Wal-Mart, a partner in the Auto-ID Center, is adopting the universal RFID standards that are being developed at the center, so much so that it recently requested that its top 100 suppliers put passive RFID tags on all shipping crates and pallets in 2005. This move by Wal-Mart likely will force the adoption of RFID capabilities worldwide because of its market clout.[56] Because of this same clout, DoD representatives met with Wal-Mart's vice president for Global Supply Chain Management to discuss the RFID technology.[57] The meeting provided the DoD an opportunity to hear from the retail leader how industry will pursue RFID technological challenges, and it served as an impetus for the DoD. It probably is not a coincidence that the USD AT&L policy letter directs DoD's suppliers to provide a passive RFID tag capability in 2005—the same as Wal-Mart.[58]

There are two impacts that may affect the DoD negatively by waiting to implement new RFID capabilities. First, logisticians responsible for DoD SCM will have to wait to track items successfully down to the tactical level using passive RFID technology. Waiting means the DoD will conduct business as usual and continue to use active RFID technology to track items at the strategic level. Second, waiting to incorporate new capabilities into active RFID tags will mean that tags in the current inventory must be available longer. Because these tags have a limited life because of their battery, some tags will have to be replaced while the DoD waits to purchase the new, smarter active RFID tags; however, the cost to replace current active tags

Option	Passive RFID	Active RFID
1	DoD should implement USD AT&L policy requiring suppliers to use passive RFID tags by January 2005.	DoD should continue to use current active RFID tags, as suggested in USD AT&L policy.
2	Same as Option 1	DoD should integrate new active RFID capabilities now.
3	DoD should wait until 2007 to integrate passive RFID capabilities.	DoD should wait until 2007 to integrate new active RFID capabilities.

Table 1. Passive and Active RFID Options Summary

because of battery failure can be viewed as a requirement for doing business. Even if the DoD decided not to purchase new active RFID capabilities, replacing a portion of the current tags at a cost of $105 each would be a necessity.[59]

On the positive side, there are two significant impacts to the DoD for waiting to implement approved RFID specifications. First and foremost, allowing time for the Auto-ID Center to address and correct the standardization and interoperability challenges that affect passive and active RFID technology will be most beneficial to the DoD. The *wait time* will ensure the DoD does not start with or continue to use a nonstandard and noninteroperable capability, which will require starting over when an approved capability becomes available. Second, one of the biggest barriers that is not allowing widespread adoption of e-tagging, using passive RFID, is costs.[60] It is expected that, starting in 2007, e-tagging will evolve into a widespread phenomenon because the cost of passive RFID tags will drop significantly.[61] Today, the least expensive passive RFID tags available cost more that 30 cents; however, manufacturing technology is moving toward the development of extremely inexpensive tags. It is expected, "in August 2007, simple passive e-tags will sell for 5 cents or less."[62] A 25-cent costs savings per passive RFID tag can result in significant savings to the DLA and commercial industry. If each of the 4.6 million items managed by DLA is fitted with a passive tag, waiting until 2007 to integrate passive RFID capabilities could result in $1.15M in savings.[63] The result is even more substantial for commercial industry; it is estimated 14 companies that are members of the Auto-ID Center would consume 412 billion RFID tags each year to tag every object they produced. Waiting until 2007 to fit all the items with 5-cent tags could result in $103B in savings.[64]

Recommendation

Option 3, which suggests that the DoD move ahead slowly with its plan to integrate passive and new active RFID technology into its supply chain, is recommended. The DoD should ensure that current RFID standardization and interoperability challenges are resolved before directing the additional use of RFID technology. The DoD's directing its suppliers to use passive RFID by eary 2005 is a bit premature. The DoD is endorsing nonexistent RFID standards effectively. As an alternative to current RFID guidelines, the DoD could adjust the USD AT&L policy by implementing a gradual integration approach. The DoD could use the early 2005 date for suppliers to provide passive RFID capabilities as a test of capabilities only. Once approved standards are released, the DoD can direct its suppliers to conform. While adjusting the USD AT&L passive RFID policy, the DoD could modify USD AT&L's active RFID strategy by requesting that suppliers provide enhanced and backwardly compatible active RFID tags for assessment in 2005. The DoD then could evaluate the new active RFID capabilities and, if deemed satisfactory, plan for a preplanned product improvement program to replace all active RFID tags in the future.

In addition to revising USD AT&L's 2 October 2003 policy and strategy, the DoD should perform a cost-to-benefit analysis to determine the amount that can be saved by waiting until 2007 for universal RFID standards and lower passive RFID tags. These cost savings should then be weighed against the DoD's benefit of having a passive RFID capability in 2005 with tags that may have to be replaced once universal RFID standards are in place.

Integrating RFID capabilities into the DoD's supply chain would clearly benefit logistics sustainment system transformation; however, there are significant drawbacks to implementing RFID technology prematurely. A study by Gartner Research provides a timetable for standardized and interoperable RFID; "e-tag standards and technology will mature so that inter-enterprise applications will be viable from 2007."[65] Postponing implementation of RFID technology will have negative and positive impacts on the DoD logistics supply chain; however, the positive impacts far outweigh the negatives. It is wise for the DoD to move forward in transforming its logistics support systems; however, it is unwise to move forward until approved and tested RFID technology standards are in place.

Conclusion

RFID technology is a critical capability needed by the DoD to transform its logistics support systems to meet future challenges and provide both warfighters and logisticians Total Asset Visibility. Both active and passive RFID technology can be used as transformation tools to provide valuable insight into DoD's global logistics supply chain and ensure the leaner and lighter military forces have the sustainment items needed when required to protect the country's national interest. To take advantage of RFID's technological innovations, the DoD has developed a strategy that will infuse RFID capabilities throughout the DoD's logistics supply chain. The DoD's desire to transform its logistics sustainment system is noteworthy; however, it is important for the DoD to proceed with caution with RFID integration because of the considerable challenges with RFID obsolescence, nonstandardization, and noninteroperability. Commercial industry is addressing the RFID challenges, but universal RFID standards will take time. There will be growing pains with integrating RFID because of the challenges with its new technology, but the positives far outweigh the negatives. The DoD should continue to participate with the commercial consortia and standards organizations aimed at developing international standards for RFID technology and implement the RFID technologies once universal standards have been approved. In the end, RFID technology will be a boon, rather than a burden, for the DoD. Ultimately, the capabilities provided by RFID technology will benefit the DoD and commercial supply chains worldwide.

Notes

1. Secretary of the Air Force, Public Affairs, Talking Points on Transformation, 9 Jan 03.
2. Joint Chiefs of Staff, *Vision 2020*, Washington DC: Government Printing Office, 2000, 1.
3. JV 2020, 24.
4. Joint Chiefs of Staff, *Focused Logistics Campaign Plan*, Washington DC: Government Printing Office, no date, 2.
5. *Focused Logistics Campaign Plan*, 11.
6. *Focused Logistics Campaign Plan*, 12.
7. Glen Bright, *Automatic Identification Technology*, logistics elective briefing, Air War College, Maxwell AFB, Alabama, Sep 03, Instructional Period 06, Slide 4.
8. *Focused Logistics Campaign Plan*, 35.
9. Logistics Management Institute, *DoD Supply Chain Management Implementation Guide*, McClean, Virginia: The Logistics Management Institute, no date, 14.
10. National Research Council, *Surviving Supply Chain Integration*, National Academy Press, Jul 02, 22.

11. "Radio Frequency Identification, RFID—A Basic Primer," AIM, Inc, White Paper, 28 Sep 99 [Online] Available: http://www.aimglobal.org/technologies/rfid/resources/papers/rfid_basics primer.htm, 15 Sep 03.
12. US Army Soldier Systems Center-Natick, "Auto-ID to Transform Military Logistics," 23 Jul 03 [Online] Available: http://www.natick.army.mil/about/pao/03/03-27.htm, 5 Dec 03.
13. *Ibid.*
14. Clark Richter, "RFID an Education Primer," Intermec Technologies Corporation, Educational White Paper, Sep 99, 1.
15. Pablo Brown, "RFID Technologies: Potential for the DoD" [Online] Available: http://www.quartermaster.army.mil/opmg/Professional_Bulletin/03/ Summer03/Commentary/, 20 Sep 03.
16. "Active and Passive RFID: Two Distinct, but Complementary, Technologies for Real-Time Supply Chain Visibility," SAVI Technology White Paper, Jan 02, 2-4.
17. *Ibid.*
18. "Active and Passive RFID: Two Distinct, but Complementary, Technologies for Real-Time Supply Chain Visibility," 5-7.
19. Joab Jackson, "The Little Chip That Could: Radio Frequency Tags Reshape Logistics," *Washington Technology*, 10 Mar 03.
20. William G. Pagonis and Jeffrey Cruikshank, *Moving Mountains,* Boston, Massachusetts: Harvard Business School Press, 1992, 205-206.
21. *Ibid.*
22. Robert Hodierne, "Moving Those Beans and Bullets," *Armed Forces Journal*, Vol 140, No 10, May 03, 16.
23. *Ibid.*
24. Pagonis and Cruikshank, 13.
25. Lucy Capaldi, "Radio Frequency Identification RFID Tags" e-mail to Howard Davis, 11 Sep 03.
26. Lucy Capaldi, Radio Frequency Identification Tags: Fact Sheet, Defense Logistics Agency Point Paper, 25 Jul 03.
27. *Ibid.*
28. *Ibid.*
29. *Ibid*.
30. Lucy Capaldi, DoD Implementation Process for Wholesale Management of RFID Tags, Defense Logistics Agency Point Paper, 25 Jul 03.
31. Capaldi, Radio Frequency Identification Tags.
32. Capaldi, Implementation Process for Wholesale Management of RFID: Operational Process and Implementation Instructions.
33. "DoD RFID Background" [Online] Available: http://www.dodait.com/rfid/RFID_back.htm, 5 Dec 03.
34. Patrick Chisholm, "RFID: In the Box Visibility," *Military Information Technology* [Online] Available: http://www.mit-mi.com/print_ article.cfm?DocID=168, 5 Dec 03.
35. *Ibid.*
36. *Ibid*.
37. Joint Chiefs of Staff, "Operation Iraqi Freedom Logistics Experiences and Lessons Identified," Directorate of Logistics Briefing, Washington DC, Sep 03, Slide 9.
38. "Operation Iraqi Freedom Logistics Experiences and Lessons Identified," Slides 9-10.
39. Dan Caterinicchia, "DoD Builds High-Tech Supply Chain," *Federal Computer Week*, 24 Feb 03 [Online] Available: http://www.fcw.com/print.asp, 4 Dec 03.
40. Michael W. Wynne, Acting USD AT&L, letter, subject: Radio Frequency Identification Policy, 2 Oct 03, 1.
41. Wynne, Atch 1.
42. Pablo Brown, "RFID Technologies: Potential for the DoD" [Online] Available: http://www.quartermaster.army.mil/opmg/Professional_Bulletin/03/ Summer03/Commentary/, 20 Sep 03.
43. *Ibid.*
44. "DLA Fact Sheet," Jun 03 [Online] Available: http://www.dla.mil/public_info/printer_friendly.asp, 5 Dec 03.
45. Wynne, 2.
46. North River Consulting Group, *Technology to Enhance Freight Transportation Security and Productivity*, Report to the Department of Transportation Federal Highway Administration, 27 Apr 02, 1.
47. *Technology to Enhance Freight Transportation Security and Productivity*, 5.
48. Gupta Puneet, "The Future of Radio Frequency Identification." *TechRepublic*, 18 Aug 03.
49. "Radio Frequency Identification, RFID—A Basic Primer."
50. *Technology to Enhance Freight Transportation Security and Productivity*, 18.
51. *Ibid.*
52. Chisholm.
53. Gartner Research, *Auto-ID Center Trials Highlight RFID Deployment Challenges*, Gartner Research Note, 1 May 03, 1-3.
54. *Ibid*.
55. Mark Roberti, "Why the Auto-ID Center Matters," *RFID Journal*, 6 Apr 02 [Online] Available: http://www.rfidjournal.com/article/articleprint /137/-1/2/, 6 Dec 03.
56. Jaikumar Vijayan and Bob Brewin, "Wal-Mart Backs RFID Technology," *ComputerWorld*, 16 Jun 03 [Online] Available: http://www.computerworld.com/printthis/03/0,4814,82155,00.html, 15 Sep 03.
57. Martin McGibney, "AMC Research Topic—RFID Technology," e-mail to Howard Davis, 12 Sep 03.
58. "US Military to Issue RFID Mandate," *RFID Journal*, 15 Sep 03 [Online] Available: http://www.rfidjournal.com/article/articleprint/576/-1/1/, 20 Sep 03.
59. Capaldi, " Frequency Identification RFID Tags."
60. "A World of Smart Objects: The Role of Auto-Identification Technologies," Gartner Research Strategic Analysis Report, 12 Aug 02, 7.
61. *Ibid.*
62. A World of Smart Objects: The Role of Auto-Identification Technologies," 9.
63. "DLA Fact Sheet," Jun 03 [Online] Available: http://www.dla.mil/public_info/printer_friendly.asp, 5 Dec 03.
64. *Auto-ID Center Trials Highlight RFID Deployment Challenges*, Gartner Research Note, 1 May 03, 1-3.
65. "DLA Fact Sheet," Jun 03 [Online] Available: http://www.dla.mil/public_info/printer_friendly.asp, 5 Dec 03.

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notable quotes

...I have dared to look into the future, but that in so doing I have based my views, not on idle imaginings, but upon the reality of today, out of which grows the reality of tomorrow.

—Giulio Douhet

EXPLORING THE HEART OF LOGISTICS

Contract Repair Asset Visibility Around the Corner: The CRISP Pilot

Christine Caroen, William Clark, Robert Heckler, Joe Mueller, Stuart Scott, and Keith Tindall

Introduction

Military operations are becoming more nonlinear, distributed, and adaptive—a trend that must continue at a rapid pace. Logistics becomes more of a challenge under these conditions.[1] The transformation of US military forces defies all progress made in the field of logistics, its business processes, and its supporting systems. It invites self-synchronization of supply and demand networks so that orders are fulfilled adequately. Key to this self-synchronization is an accurate global view of operations, from location of demands to location of supplies. Visibility is crucial. Some technologies enabling visibility—for instance, radio frequency identification—are quite complex, cutting-edge, and expensive while others are readily available, increasingly simple, and can be applied now. About 2 years ago, a Defense Sustainment Consortium (DSC) team investigated the application of one of these readily available technologies to contract repair parts supply.

The Pilot

The DSC sponsored a pilot program through the Defense Logistics Agency (DLA) with the Air Force called Contract Repair Information System Protocol (CRISP). The team included participants from the Air Force Materiel Command, Warner Robins Air Logistics Center, Defense Logistics Agency, Defense Automated Addressing System Center (DAASC), Rockwell Collins, ICF Consulting, and Altarum. The pilot focused on applying XML technology (extensible markup language) to enable automatic real-time reporting of repair status between commercial repair contractors and the Air Force and evaluated its impact on the contract repair parts supply process.

Altarum's role in the CRISP pilot was to conduct the project demonstration and evaluate its performance. The mission of Altarum is to transition cutting-edge supply network innovations into a practice that results in a business value to clients, who can continue to reap the rewards of improvements. Altarum saw a an opportunity for Air Force Supply Chain managers to have increased visibility into the contract repair supply chain network. Piloting the XML-enhanced communication between repair contractors and the Air Force would allow measuring the worthiness of the proposition and crafting the transition of the technology for wider use within the Air Force and Department of Defense (DoD).

Rockwell Collins was to represent a typical OEM* who serves as a repair depot for the Government (Air Force). Rockwell Collins participated in the CRISP pilot for two main reasons. First and foremost, Rockwell Collins is a leader in the use of information technology in its daily operations and realized this would be an opportunity to help determine future requirements for transfer of data between repair contractors and the Government. Second, it perceived other benefits of a successful CRISP pilot, including the elimination of manual data entry into multiple government systems, timely and accurate data available to the customer without having to contact Rockwell Collins, and timely and accurate performance metrics.

DAASC's role was to be the interface between a DoD automated supply system and a private sector contractor that is providing logistics support services. In this case, Air Force Materiel Command's (AFMC) prototype Logistics Management System is exchanging contractor repair status information with Rockwell Collins. As a value-added service provider and an eBusiness hub, DAASC provides the telecommunications link between the two partners and, in the future, may provide translation services to allow systems using dissimilar data formats to exchange data. DAASC chose to participate in this pilot because this is a natural extension of the services it has been providing for 30+ years. DAASC likes to take advantage of these opportunities to establish new relationships and gain experience with new transmission protocols such as XML.

ICF Consulting's role in the pilot was to act as the technical lead in the team effort to develop system requirements, design, development, and implementation. ICF Consulting provides technical consulting to a wide range of federal, state, and local government agencies. For the pilot, ICF was excited about participating in a cutting-edge project with significant potential for positive impact on DoD logistics support, increasing company expertise and experience in technologies, and working with the highly capable members of the team.

The Contract Repair Parts Supply Process

The Air Force contracts with private companies to produce, maintain, and repair a substantial part of its inventory. Military

(Continued on page 44)

Lessons for Transforming Logistics

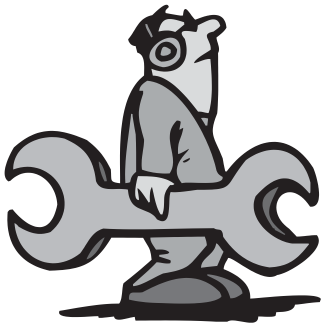
The new wing structure consists of four groups: the operations group, maintenance group, mission support group, and medical group. Transformation is likely to continue, and organizations will likely continue to evolve to support changing mission requirements within current resource constraints.

logistics history

Maintenance Organization: A Historical Perspective

As the Air Force has evolved, many factors have come into play with respect to the organization of aircraft maintenance functions—technology (to include systems and systems reliability and maintainability), budgetary constraints, spares availability, manpower availability, and training. From a historical perspective, in response to these factors, two trends can be seen—alternating centralized decentralized operations and moving between standardized and MAJCOM-driven maintenance organizations. As a backdrop for transformation and lessons to be learned, "Maintenance Organization: A Historical Perspective" reviews the evolution of the Air Force maintenance organization.

A historical perspective
Maintenance Organization



The rapid growth of aviation during World War I increased the need for airplane mechanics and engineering officers.

Over the years, many factors have affected the way aircraft maintenance has been organized, including training requirements, technician skill levels, availability of personnel (manning levels), availability of spares, budgetary constraints, and technical systems reliability and maintainability. Historically, training requirements have increased as aircraft complexity has increased. As the manpower levels were decreased, generalist training was resumed—but only until aircraft complexity drove the need for greater specialization.

Maintenance Organization During the Early 1900s

World War I, Decentralized Maintenance

Prior to 1917, the flying squadron had evolved as the established tactical unit. The squadron commander was responsible for upkeep and repair of all airplanes and equipment under his command. Aviation mechanics, enlisted men of any grade, were appointed after testing. There was a basic company and section formation; officers were pilots who were also in charge of section maintenance. Aircraft were technologically unsophisticated, and enlisted personnel were experts on the entire aircraft.

After World War I, when Major General Mason M. Patrick became chief of the Air Service, he issued Memorandum No 37, which established the Air Service plan for the supply, salvage, and repair of airplanes. The effect of this memorandum was to establish echelons of maintenance, which would be the accepted structure and the basis for different repair levels and locations for many years. The plan called for a network of groups, mobile parks, air depots, intermediate depots, depots, acceptance fields, and production centers. The first echelon cited in the memorandum was the group, made up of squadrons, which performed aircraft and engine maintenance repairs at the local level. The group was designed to be a self-contained unit, not constrained with heavy equipment that would hinder its mobility.[1]

The rapid growth of aviation during World War I increased the need for airplane mechanics and engineering officers. By 1918, the aero squadron was established. The aero squadron consisted of four sections: headquarters, engineering, supply, and flying. Maintenance was within the engineering section. For airplanes, a repair crew—consisting of a crew chief, an assistant crew chief, and various mechanics—was established. The crew chief was the individual responsible for all servicing and repair of the aircraft. Soon after entry into World War I, maintenance organizations at flying fields could not handle overhauls and complicated repairs, so maintenance depots were established, centralizing some repair. The depots were located in Dallas, Texas; Montgomery, Alabama; and Indianapolis, Indiana.[2]

During the 1920s, as equipment advanced, maintenance at the squadron level improved with the introduction of aircraft record keeping (such as aircraft condition record, record of receipt of the airplane, and daily airplane crew report). The introduction of instruments, cameras, radios, and armament—still relatively simple machines—

Aircraft complexity has driven the need for maintenance specialization and caused aircraft maintenance to be reorganized many times since the 1900s.

brought about the first major specializations. Training of airplane mechanics was still very broad. The mechanic was qualified in all systems except armament, camera, and radio. This generalist training led to the establishment of a crew chief system of maintenance. The crew chief became a second-term master mechanic and a graduate of Chanute Field, Illinois, master mechanics courses. The crew chief and his crew members maintained the airframe, engines, controls, and accessory systems. The specialist who was not assigned to the crew maintained armament, cameras, and radios. The specialists were assigned to a service squadron or company, usually collocated on the flying field, and performed maintenance beyond the capability of the crew chief and his crew.[3]

World War II, Centralized Maintenance

By 1939, the Army Air Service was still relatively small, with an inventory of fewer than 2,000 aircraft. The Air Service's Engineering Division at McCook Field, Ohio, was combined with the Supply Division and the Industrial War Plans Division and moved to Wright Field, Ohio. This new organization was titled the Materiel Division. It was responsible, in part, for establishing maintenance criteria, policies, and procedures and for exercising authority over all maintenance performed at flying units throughout the continental United States (CONUS).[4]

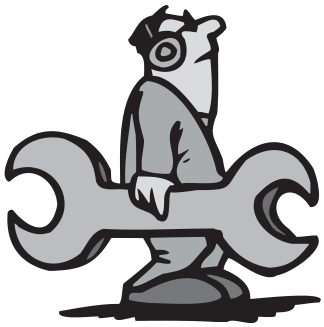
Using the cumulative experience of World War I and the postwar period, the newly named Army Air Corps gradually evolved into a new version of the echelon maintenance system. First echelon maintenance was work accomplished by the crew chief of the basic combat unit and included pre- and postflight inspections and minor repairs and servicing. Second echelon maintenance was accomplished by the crew chief with assistance from service squadron shops and included periodic inspections, adjustments or replacement of equipment, and engine changes. Third and fourth echelon maintenance was done at subdepots and depots.[5]

The first significant effects of technology on maintenance were seen with the adoption of metal tubing and pressed metal construction. These materials required a new class of skilled mechanics to handle the welding and riveting operations. The all-metal aircraft had controls, armament, and even landing gears that were tucked away out of the slip stream to increase speed, range, and performance. Accessibility decreased, making maintenance on these systems more difficult. One other significant change concerned the method of determining aircraft overhaul. The old method of the engineering officer's determining when the aircraft required depot overhaul finally evolved to the 1939 policy of using flying hours as the criterion.

World War II led to enormous growth in the Army Air Corps. In maintenance, flight chiefs and line chiefs became maintenance officers overnight; apprentice mechanics became line chiefs. The demand for mechanics exceeded the supply. The course length at Chanute was reduced to get mechanics into the field sooner. The broadened crew chief training was replaced by shorter, specialized training, producing the modified crew chief system. The new system included a crew chief with a crew of airplane general and engine mechanics who were responsible for flight-line and periodic maintenance. A pool of specialists was located within the squadron to aid the ground crew. The large number of people involved in aircraft maintenance drove the need for a structured maintenance organization in the combat group to replace the previous year's approach of operating under each flying squadron.

During this era, overseas theater commanders were allowed to modify or even ignore the maintenance organization structure that was mandatory in CONUS.[6] These overseas units were varied and adapted to local situations. The maintenance situation overseas was one of hard, long hours, but the outlook was generally bright, with rapid promotions, excellent parts availability, development of excellent skills, and units of high-capacity and high-quality maintenance.

Overseas operations contrasted starkly with stateside conditions, where aircraft were limited and often war-weary assets brought back from overseas, supplies were limited, and maintenance personnel were often inexperienced trainees. The stateside requirement was still one of vast amounts of flying time to train combat crews and constant recycling of trainees. These conditions prompted a high degree of specialization; teams and functional groupings of maintenance personnel were established in a dock system where hangar crews accomplished scheduled inspections in accordance with jobs that were sequenced. For each task, people were trained solely against that task. Workflow through the dock was carefully scheduled, and postdock maintenance was developed to clean up carryover work. Engine buildup went through the same high degree of specialization. The result, organizationally, was a mandated, highly structured organization to manage these specialized assets.



Prior to the National Defense Act of 1947, which established a separate Air Force, maintenance organizations had many top-level maintainers but few skilled mechanics.

A combat group had a commander for all group maintenance, which was done in a maintenance section headed by an engineering officer. The section was divided into two branches: a flying line maintenance branch and a production line maintenance branch, each headed by an assistant engineering officer. The flying line maintenance branch was broken into four units: one each for maintenance, servicing, armament, and communications. This branch was responsible for servicing, preflight, daily and 25-hour inspections, filling out forms, all contact with aircrews, replacement of aircraft and engine units (unless it would involve excessive out-of-commission time), and accomplishment of technical order changes.

The production line maintenance branch consisted of 14 units: one each for cockpit and cabin, cleaning, flight controls and surfaces, hydraulic and landing gear, engine, fuel and oil, electrical, instrument, propeller, armament, communications, metal repair, ground equipment repair, and parachute. This branch was responsible for washing and cleaning; accomplishment of 50-hour, 100-hour, and other periodic inspections; engine changes; and technical order changes beyond the capability of the flying line maintenance branch. The production branch also changed major assemblies; did metal repair and maintenance and servicing of flight-line and hangar equipment; and prepared engines and aircraft for return to supply or depot and aircraft for return to depot.[7]

Post-World War II, Decentralized Maintenance with Centralized Control

After World War II, regulations began to be used to define maintenance organizations. These regulations reflected both previous experience and the changes brought about by differences in technology, personnel availability, and mission requirements. In August 1945, the US Army Strategic Air Forces published Regulation 65-1, *Combat Maintenance Procedures*.[8] This publication established a decentralized maintenance section with strong centralized control in the form of wing maintenance control. It also provided for a combat maintenance officer and specialized maintenance organizations, including flight-line maintenance, scheduled maintenance, engine buildup, and servicing. This regulation set the stage for postwar maintenance organizations and procedures.

Prior to the National Defense Act of 1947, which established a separate Air Force, maintenance organizations had many top-level maintainers but few skilled mechanics. A huge postwar loss of skilled mechanics, no strong enforcement of any maintenance system, and the introduction of new jet-powered aircraft in the form of the Lockheed P-80 led to these conditions. Prior to establishment of the new service, Army Air Forces Regulation 65-1, *Supply and Maintenance Program of the Army Air Forces*, was released as a revision to the former 65-1. This revision did little other than to call out the new terminology (organizational, field, and depot maintenance) replacing the older echelon maintenance concept. On the flight line, virtually nothing changed, because the functional organizational structure remained unaffected.

Establishment of the Air Force

A Standardized, Decentralized Maintenance Structure

Standardization of the wing and base organization under what was called the Hobson Plan was the Air Force's first action affecting maintenance.[9] The Hobson Plan replaced the World War II combined Combat and Service Group to provide unity of command and make the best use of what was a diminishing postwar personnel pool.[10] Four groups were established: the combat group, maintenance and supply group (M&S), airbase group, and medical group.[11] While organizational maintenance was placed in the combat group under the flying squadron commander, field maintenance was placed under the maintenance and supply group.

Because of greatly reduced flying requirements, top-heavy manning from experienced noncommissioned officers, and the relative simplicity of aircraft after World War II, the more traditional crew chief system was largely restored. These crew chiefs managed all work on an aircraft and supervised a team of mechanics in a classic, decentralized maintenance posture. The crew chief only occasionally had to request assistance from the field maintenance (third echelon) organization.

Berlin Airlift, Centralized Maintenance

Between June 1948 and September 1949, what became known as the Berlin Airlift was conducted. Maintenance for this airlift effort was organized as described in the Hobson Plan. Lieutenant General Curtis E. LeMay, commander of United States Air Forces in Europe (USAFE) at the time, determined that the crew chief system could not be adapted to work in the around-the-clock flying situation because of the limited number of hours a person was permitted to work. He decided that the only system capable of filling the requirements was the specialized, centralized maintenance system.

Thus, specialized aircraft maintenance was again employed, this time to support the Berlin Airlift.[12] Depot support was used extensively, and a central engine buildup line was operated at Rhein Main AB. Two 100-hour inspections were accomplished at Burtonwood Air Depot, and contractors in CONUS did 1,000-hour overhauls of C-54 aircraft.[13] The Berlin Airlift saw the first formation of a central production control at the Combined Airlift Task Force (CATF) Headquarters at Rhein Main. The central production control for airlift forces was established to monitor maintenance status, location, supply status, and other related maintenance data for all CATF aircraft. The consolidated control center scheduled all work for Burtonwood and CONUS with all lift bases.[14] An electronics squadron was formed, located in Berlin, to repair C-54 radio and radar components. The Berlin Airlift adapted the existing maintenance system, centralizing control, specialist maintenance centers, and extensive depot assistance. Another important adaptation was in the role of top-level command (leadership) in advocating or mandating major command (MAJCOM) or Air Force maintenance policy.

The 1950s, A Variety of Maintenance Organizations

LeMay became commander of the Strategic Air Command (SAC) in late 1949. Shortly after, SAC adopted a more specialized maintenance concept. SAC Regulation (SACR) 66-12, Maintenance Management, was written to "establish a functional aircraft maintenance organization within the wing/base organization, which would ensure full utilization of personnel and facilities to produce maximum availability of aircraft."[15] This required organizational change marked the first formal move toward centralized maintenance in the Air Force. The M&S group was disbanded, and three maintenance production squadrons were established: field maintenance, periodic maintenance, and electronic maintenance. The organizational maintenance capability was retained in the operational flying squadron in the combat group.[16] The main agency in this new structure was the wing maintenance control, which was responsible for the centralized direction and control of the wing's maintenance effort.

Other MAJCOMs were experimenting with different maintenance organizations during this period. Most retained the M&S group and were based on the crew chief's being supported by specialists where organizational maintenance was under the operational squadron commander.[17] The exception was Air Training Command (ATC), where the organizational maintenance squadron (OMS) was under the M&S group commander because of ATC's limited mobility requirements. In SAC and Tactical Air Command (TAC), when units deployed, they included specialists from the M&S group in order to be a self-sufficient deployed organization. The Military Air Transport Service (MATS) used a variation of specialized maintenance. All commands faced skilled personnel shortages.

In June 1950, the North Koreans invaded South Korea, and the United States again was involved in an armed conflict. The standard M&S system in place at the time—even SAC's version under SACR 66-12—was not suitable for meeting mission requirements, largely because of combat conditions and inadequate forward-based facilities from which to conduct maintenance operations. Consequently, a system of rear-echelon maintenance bases in Japan and Korea evolved. Combined with the rear units, these rear-echelon maintenance bases were known as rear echelon maintenance combined operations (REMCO).[18]

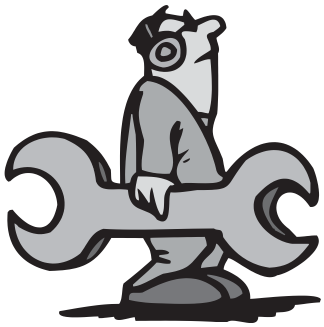
Crew chiefs at forward bases, with their crews, performed preflights, turnarounds, battle damage repair, preparation for a one-time flight to rear bases, and armament maintenance. Maintenance at these forward locations was limited to the quick-turnaround type of work aimed at keeping a maximum number of aircraft airworthy. The inability to achieve base self-sufficiency at forward locations made the REMCO adaptation necessary.

In 1953, ATC moved closer to centralized maintenance by forming periodic squadrons and placing all specialists in the field maintenance and armament sections. Also, planning and scheduling were moved to the chief of maintenance level, quality control was expanded, and dispatch of all specialists was accomplished by maintenance control.

About this time, Air Defense Command (ADC) was having considerable trouble maintaining the new F-86D aircraft with its airborne radar and integrated electronic fuel system control. To counter the problem, ADC relied on specialists' being given more extensive training and improved specialized technical orders and instructions. The result was reduced accident rates and higher aircraft availability for the F-86D.[19] This concept of breaking out aircraft systems into functional areas, with each area maintained by its own specialist, eventually was approved by the Air Staff and continually expanded as newer aircraft and significantly more complex systems were introduced into the inventory.

Also in 1953, the Air Force Inspector General (IG) began to question whether the montage of different maintenance concepts among MAJCOMs was serving the best interest of the Air Force. In a landmark semiannual report to the Chief of Staff, he pointed out:

> As a result of over one hundred (100) inspections, both readiness and technical, conducted by this office, it was determined that no universally effective specialized and standardized system of aircraft maintenance existed in the Air Force. The one notable exception is the Strategic Air Command, which has made a concerted effort to achieve a modern concept of maintenance and was experiencing excellent results in the conservation of skills, tools, facilities, and materials. Other commands, however, were employing various methods and systems of aircraft maintenance largely at the discretion of local commanders and maintenance officers.[20]



The increasing complexity of aircraft and the need for greater specialization saw more acceptance of centralized maintenance.

In December 1953, the Air Force published Air Force Regulation (AFR) 66-1, *Maintenance Engineering*. It was the first Air Force regulation dealing with maintenance management. Only four pages in length, it defined three levels of maintenance (organizational, field, and depot). It temporarily gave MAJCOMs authority to tailor maintenance organizations to suit their missions and types of aircraft. But it issued this caveat:

> Frequent reexamination of the Air Force maintenance structure will be made to ensure that organizations, facilities, equipment, and specialists are available and fully able to meet the support requirements of newly introduced items of equipment or weapon systems.[21]

In early 1955, the Air Staff initiated a study at Dover AFB, Delaware, a large MATS flying wing. Conducted by an Air Force management engineering team, the study proposed that organizational maintenance be removed from the operational flying squadron and consolidated with field maintenance under a wing chief of maintenance.[22] After 9 years as a service, the Air Force published definitive guidance on maintenance organizational structure on 1 September 1956. That guidance, in Air Force Manual (AFM) 66-1, *Maintenance Management*, was patterned after SACR 66-12 and incorporated the basic guidelines of AFR 66-1 and its revisions.

AFM 66-1, Centralized Maintenance

AFM 66-1 established a chief of maintenance responsible for all aircraft maintenance in the wing and reporting directly to the wing commander. The chief of maintenance was assisted by a staff to help in central control of all maintenance activity. Three squadrons worked directly for and reported to the chief of maintenance: the organization maintenance squadron, field maintenance squadron, and electronics maintenance squadron. The actual organizational structure was not new; it was a formalized version of existing structures. The manual set Air Force standards, goals, and objectives for maintenance, which included aircraft in-commission rates, component repair standards, and aircraft scheduling objectives, among many others. It also established the requirement for man-hour accounting and maintenance data collection, a major initiative.

When AFM 66-1 was first published, implementation was a MAJCOM option. It met with numerous objections and, other than in SAC, only perfunctory compliance.

Operational flying squadron commanders were leery of the "new and yet unproven system."[23] The centralized control aspect of AFM 66-1 meant to many that organizational maintenance would be taken out from under operations control. Centralized control of maintenance had the support of Air Force Chief of Staff General Thomas D. White, however, and in 1958, he made it mandatory for all Air Force organizations.[24]

As directed, all commands began to use AFM 66-1 in the 1960s. The increasing complexity of aircraft and the need for greater specialization saw more acceptance of centralized maintenance. Crew chiefs assigned to OMS worked on the flight line, assisted by other OMS (airplane general) resources. All other specialist personnel were assigned to either a field maintenance squadron or electronic maintenance squadron and later to armament and electronics squadrons and to munitions maintenance squadrons. These specialist personnel were located off the flight line and were dispatched to assist crew chiefs as necessary, requiring communications and coordination through job control (chief of maintenance staff personnel), which, in turn, required paperwork and documentation. This process involved high numbers of overhead persons, who were not directly involved in sortie generation on the flight line.[25]

Complex systems introduced with century series aircraft (particularly F-101, F-102, and F-106 aircraft) assigned to the Air Defense Command and similarly complex systems on SAC bombers drove the development of large numbers of specialists, particularly in avionics squadrons and, to a lesser extent, munitions maintenance squadrons. Systems aboard these modern fighter and bomber aircraft were so numerous and complex that technical schools generally required 52 weeks to complete technician training. Even then, further on-the-job and field training detachment training was required once the technician arrived at an assigned unit. Systems often failed, and repairs were lengthy. Only through specialist pools (mixtures of personnel with back-shop experience and personnel with on-equipment experience) could demands be met.

When new weapon systems were brought into the inventory, large cadres of technical representatives, many of them engineers, were provided by the prime and original equipment manufacturers. These technical representatives were used both for training and hands-on maintenance and had priority access to their firms' technical staffs.

Indeed, these factors, combined with others, produced high Air Force tactical fighter mission capable (MC) rates through the 1960s. The Air Force F-4 Phantom series aircraft was relatively new. Contractor technical representatives were embedded in maintenance organizations, and a large number of them were assigned across CONUS and Southeast Asia (SEA) units. Funding was readily available for SEA operations. The quality of both officer and enlisted training improved, and course durations increased. The senior workforce and management experience increased.

Vietnam Conflict, Decentralizing Trend

AFM 66-1 was practical for all MAJCOMs and gained general acceptance, but it was seriously tested, particularly in TAC, during the Vietnam era. Depending on existing manning levels, deployments may have made it difficult to cover specialist support requirements. Early deployments of smaller units (squadrons) to participate in the Vietnam conflict had austere manning, creating maintenance deficiencies and long hours of work. But temporary duty gave way to permanent change of station assignments, and squadrons often deployed with the same personnel assigned to them at home stations. The Air Force placed flight-line maintenance back into the tactical squadrons under operations. Personnel were identified with squadrons in CONUS so that peacetime work integrity would be maintained when deployed.

In the Pacific Air Forces (PACAF), PACAF Regulation 66-12 was issued. This regulation realigned the OMS maintenance officer administratively to the flying squadron but left him working for the chief of maintenance. The flying squadron commander thus rated OMS personnel even though they functionally worked for the chief of maintenance.

In 1966, TAC published TAC Manual (TACM) 66-31, instituting what was known as *TAC Enhancement*. Flight-line personnel moved from OMS into the tactical flying squadrons. Munitions load crews were likewise moved, phase was moved into the flying squadron from field maintenance squadron, and some specialist support was placed into the flying squadron for limited on-aircraft work, primarily removal and replacement of components.[26]

The new program was described in *TAC Attack* as an:

> …interim reorganization (which) will enhance the efficiency of maintenance functions within deployed and dispersed unit…from the moment they deploy. Continuity of supervision will not be interrupted. Squadrons will be better able to cope with the unavoidable problems of dislocations. Overall, decentralization will improve the capability of TAC's fight and reconnaissance squadrons to continue their worldwide mission.[27]

A little more than 1 year after LeMay retired as Chief of Staff, the tactical fighter community returned to decentralized maintenance.

The Early 1970s, Downsizing and Centralizing

Budgetary cuts accompanied the phasing down of military involvement in Southeast Asia. The duplication of resources resulting from TACM 66-31 no longer could be supported. By 1972, the number of Air Force members had dropped to its lowest since 1950, a 16-percent reduction just since 1966.[28]

Declines in MC rates for tactical fighters were related more to manpower reductions, skill-level reductions, introduction of complex new weapon systems (as with the F-111 series), increased problems with maintaining F-4 aircraft (now getting older), and spares reductions rather than to organizational structure. The move back to centralized maintenance became necessary to deal with the declining specialist availability and skill levels. The declining MC rates for these aircraft continued to grow despite the change back to the centralization that had earlier produced higher capability rates.

Studies done in USAFE showed that the F-4 aircraft could not be turned fully mission capable on a daily basis.[29] This was primarily because of the declining mean time between failure of F-4 systems and subsystems. Similar problems with the F-111 are also well-documented. There were enough F-4s to meet peacetime flying training requirements but not enough to generate the sortie surge requirements predicted under the War Mobilization Plan.

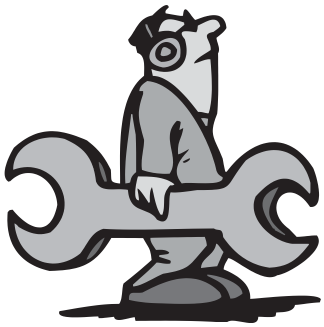
It could be argued that no form of organization would have made a difference in maintaining these complex and low-reliability weapon systems.

On 1 August 1972, the Air Force published a major revision to AFM 66-1 that greatly expanded maintenance guidance. The new manual consisted of ten volumes that covered every detail of Air Force maintenance, including that for aircraft, missiles, and communications equipment.

In the foreword of the new AFM 66-1, Chief of Staff General John D. Ryan said:

> Economy in the use of resources can only be achieved by balancing operational requirements and maintenance capability. This requires planning and comprehensive scheduling of equipment maintenance. Management effectiveness can then be measured in terms of maintenance accomplishments.[30]

The new manual emphasized "making equipment available for maintenance when the resources are available." Lieutenant Colonel Thomas E. Reiter noted in his Air War College thesis, "This was a significant philosophical change because, in the past, maintenance was performed whenever the aircraft were not on the flying schedule and the new policy basically called for the aircraft to be on the flying schedule whenever they were not required to be in maintenance."[31] This marked the first time such definitive guidance had been given from such a high level. Ryan's comments on balancing requirements in operations and maintenance and his measures of merit do not imply an organizational structure.



POMO was designed from lessons learned from the Israeli Air Force during the 1973 Arab-Israeli war (Yom Kippur).

The strict adherence to a rigid program of reporting and documenting maintenance actions, the establishment of MAJCOM evaluation teams to ensure compliance, and rigorous IG inspections and operational readiness inspections seemed to provide a clear message that the years of flexibility in the area of maintenance organizational structure were over. This standard manual and its organization were the final authority and discouraged further innovation.

In USAFE, from 1971 to 1974, General David C. Jones, Commander in Chief, USAFE, set several initiatives in motion that would have a broad impact on maintenance organization in the future. Jones became concerned with more effective use of USAFE resources.[32] USAFE's Project Streamline evaluated extensive initiatives, including cross-utilization training of maintenance personnel. A separate initiative, briefed to Jones prior to his reassignment as Air Force Chief of Staff, dealt with centralizing maintenance even further and called for centralized intermediate repair facilities (CIRF) to support forward base operations in wartime to reduce airlift requirements and the logistics footprint.

USAFE Vice Commander Lieutenant General Louis Wilson was reassigned to PACAF to take over as PACAF Commander in Chief. He asked for a staff paper that he would use to implement the CIRF concept at Kadena AB. Jones, then Chief of Staff, established the Maintenance Posture Improvement Program (MPIP) in 1976 to "find new ways of going about the complicated business of maintenance, which would permit more efficient and effective use of the total Air Force maintenance resources."[33] The CIRF project studies were included as part of the MPIP. The proposal in USAFE and the CIRF activities within PACAF to centralize intermediate maintenance became widely known. While there was basic Chief of Staff agreement to continue to pursue the feasibility of the proposed centralization where applicable, the proposal met with significant opposition among proponents of base self-sufficiency, particularly within TAC.

To respond to MPIP and, likewise, respond to USAFE and PACAF centralized maintenance initiatives, TAC proposed and tested a new base-level maintenance organization called the Production Oriented Maintenance Organization (POMO).

The Mid-1970s, POMO and Decentralized Execution with Central Control

POMO was designed from lessons learned from the Israeli Air Force during the 1973 Arab-Israeli war (Yom Kippur). The Israeli Air Force was able to generate high sortie rates by cross-utilizing skills of personnel and assigning them to a flight-line organization where they were directly responsible for repairing, servicing, and launching aircraft. People not directly contributing to generating aircraft were assigned to back shops. A TAC team sent to Israel said the Israeli system of maintenance

"appeared to have great possibilities in the fighter environment," where "rapid aircraft turnaround, sortie generation, and surge capability were essential."[34] Under POMO, specialists from the electronic maintenance squadron, field maintenance squadron, and munitions maintenance squadron were assigned directly to the flight line and placed in the same squadron as aircraft generalist crew chiefs or airframe and powerplant generalists.

The resulting squadron was named the aircraft generation squadron instead of OMS because it was now able to handle all on-equipment maintenance. The aircraft generation squadron consisted of aircraft maintenance units, which were aligned respectively with flying squadrons. In some cases, weapons load crews also were assigned to an aircraft generation squadron as weapons maintenance units. The remaining specialists were grouped in two new squadrons—the equipment maintenance squadron and the component repair squadron—and performed all off-equipment maintenance. The POMO often is described as decentralized execution with centralized control because the chief of maintenance and his staff remained the same and maintenance and job control continued to control the entire maintenance effort.

During this same time, the F-111 ushered in a new flight-line remove-and-replace (2R) era of maintenance, which meant fewer specialists were required for on-equipment maintenance. This move to 2R maintenance also resulted in less detailed technical training for many specialists. Now aircraft began to incorporate self-test/built-in-test features that eliminated the more detailed on-equipment troubleshooting seen in the past. With the introduction of avionics intermediate shops and modular engine components, on-equipment maintenance became less specialized.

Upon implementation, the POMO structure did not increase sortie production as expected. One comprehensive study found that POMO "has had little, if any, positive effect on aircraft maintenance in a peacetime operating environment."[35] The study found strong indications that POMO had caused some degradation in aircraft maintenance performance. It stated in its discussion of implications for management that "if the Air Force wants increased productivity, then one or all of the components of maintenance efficiency must be improved" and that "organizational efficiency has in many cases only a limited impact on the overall efficiency of a maintenance action when compared to what is embodied in the sequence of tasks required in the maintenance action itself."[36]

The Late 1970s and 1980s, Increased Decentralized Execution, Less Centralized Control

When General Wilbur L. Creech took command of TAC in 1978, he ordered his own study. It found that sortie production had fallen 7.8 percent from 1969 to 1978 and concluded that this decline was attributable not to external factors but simply to maintenance's inability to produce the required sorties.[37] The new TAC Commander felt the organization of maintenance was a major factor in this decline and led TAC to create the Combat Oriented Maintenance Organization (COMO), formalized under TAC Regulation (TACR) 66-5.

TACR 66-5 differed from POMO in many ways. Each squadron aircraft maintenance unit now performed its own scheduling and was responsible for its own utilization rate. Each squadron aircraft maintenance unit had its own dedicated analyst. Supply was decentralized to each aircraft maintenance unit, and the wing-level maintenance supply liaison was eliminated. Each squadron aircraft maintenance unit performed its own debriefing, had its own pool of aerospace ground equipment, and dispatched its own flight-line personnel to jobs. And a dedicated crew chief was assigned to each aircraft. The deputy commander for maintenance (DCM) remained responsible for all maintenance and reported to the wing commander. Maintenance control now *coordinated* maintenance activities more than it *controlled* maintenance. COMO also proved to be very manpower intensive.

The MC rates for tactical fighters continued to increase. One report declared:

> The results of the transition to COMO have been dramatic. Sortie production, from the third quarter of 1978 to 1983, rose at an annual rate of 11.2 percent. In the first full year under COMO, 1979, TAC flew all its programmed sorties for the first time in a decade.[38]

In 1990, the MC rates increased to an all-time high of 88.4 percent. When considering the increased sortie rates reported by TAC between 1978 and 1983 and beyond, however, consideration needs to be given to the fact that the period also saw a changeover to more modern and more reliable tactical aircraft, better technical data through the introduction of job procedural aids and guides, better automatic test equipment, and more accessibility and better maintainability because of technology advances and lessons learned from F-4 and F-111 problems. All could have had an impact on the increased MC rates.

Interviews with senior maintenance officers indicated that the senior management workforce during the changes to COMO had considerable experience and careful career management. The rated supplement (to maintenance) and the maintenance officer career fields both had specialized career management through the Military Personnel Center. The rated supplement had its own branch, and Palace Log was established within the Officer Management Division, both carefully managing individual careers and tracking high performers and assisting them to grow into commander's jobs and DCMs. Palace Log often took in first assignment instructor pilots who had finished their tour teaching new pilots and could find no open cockpit slots. They were then placed in maintenance and became advocates of maintenance as they progressed through their rated careers.

In addition, there was consensus among the senior maintenance managers interviewed that, during COMO, there was a highly trained professional maintenance workforce backed up by senior technicians who had considerable skill in the older mission design series that would soon be replaced by newer, more reliable, and easier-to-maintain tactical aircraft. These professional maintainers saw COMO as more effective than–but perhaps not as efficient as–the previous, centralized maintenance. It is also important to understand that the transition from POMO to COMO was not a major reorganization but, instead, a realignment of responsibilities and functions.

The Early 1990s, MAJCOM-Specific Maintenance Organizations

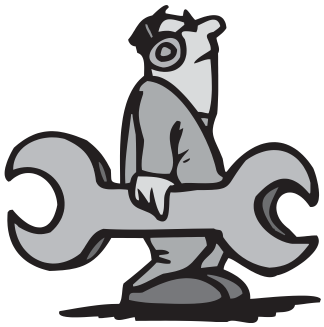
MAJCOMs in 1990 were operating mostly in modes acceptable to each while still pursuing optimal maintenance concepts more

suited to ever-changing operational requirements. Tactical air force MAJCOMs finally had adapted COMO to their requirements. SAC formally implemented a decentralized structure in 1987, the implementing directive being SAC Regulation 66-14, *Readiness-Oriented Logistics System (ROLS) Maintenance Management General Policy, and Deputy Commander for Maintenance (DCM) Staff Activities*. ROLS was similar to COMO and obviously influenced by it, but AFM 66-1 was still visible.[39] The Military Airlift Command (MAC), the most consistent of the MAJCOMs in terms of maintenance organizational structure, remained committed to centralized maintenance; its implementing directive was MAC Regulation 66-1, *Maintenance Management Policy*.[40]

During Desert Shield and Desert Storm:

> …maintenance organizations were to be aligned under AFM 66-1 procedures..... The CENTAF/LGM was a staff advisor to deployed wings. Each base installation having more than one wing would have a lead unit DCM who would then appoint senior tenant wing maintenance officers as assistant DCMs. Collocated units were to be prepared to form joint maintenance operations centers (JMOCs) and job control (JC) units.[41]

In fact, each MAJCOM maintained aircraft in accordance with its peacetime organizations.



The organizational aspects of the transition to the EAF resulted in the designation of ten air and space expeditionary forces that rotate their availability for deployment and rapid response on a periodic basis.

The one notable difference from tactical fighter support in peacetime was the establishment of CIRFs out of theater (in USAFE or at home bases) for avionics (except electronic countermeasure pods) and engine maintenance.[42] In part, the acceptance of centralized intermediate maintenance was driven by a compromise between the need to limit population in the area of responsibility and the desire for self-sufficiency. There was concern that lines of communication would be interrupted if intermediate maintenance were out of the area of responsibility, but this concern gave way, in part, to the limited number of people the theater could support.[42]

One other major maintenance variation occurred with the establishment of the 7440th Composite Wing (Proven Force) consisting of ten different mission design series aircraft. The wing established seven aircraft maintenance units (one for each flying squadron), a combined component maintenance and equipment maintenance section, and an ammunition branch out of the 39th Consolidated Aircraft Maintenance Squadron and deployed USAFE units. The official history of Proven Force states that monitoring of the parts flow was highly effective but also was cumbersome and manpower-intensive, requiring manual tracing of as many as 500 pieces of cargo each day. Proven Force MC rates were approximately the same as those for peacetime and similar models of aircraft.[45]

The Mid- and Late-1990s, Objective Wing Decentralized Structure

When General Merrill McPeak ordered the change to the objective wing, he was issuing a major change to the combat air force (CAF), although the objective wing was an effort to standardize organizations across all commands in the Air Force. This standardization effort, which applied to all Air Force wings, was based on McPeak's description as "one base, one wing, one commander."[46] It was intended (again) that Air Force wings should train as they fight. It accomplished this by having a single wing commander at each base, with flight crews and flight-line maintenance personnel working for the flying squadron commander, who reports to the operations group commander. The back-shop maintenance, supply, and transportation personnel would work for a logistics group commander.

Some variations were made to this basic objective wing structure in 1992 when a deputy for operations group maintenance was created to provide overall supervision for all flying squadron maintenance, the phase docks, and interface with the logistics group commander to resolve issues with back-shop or other supply and transportation support of sortie generation and phase activities. Maintenance control had become the maintenance operations center under the wing. Quality assurance was also under the wing. The net result for CAF units was to return them more closely to traditional squadron maintenance. The logistics interface with organizational-level maintenance (sortie generation) was minimal except through interface with the operations group, and in some instances, a maintainer did not fill the logistics commander billet.

Several MAJCOMs had objective wing variations approved, permitting them to keep all maintenance responsibilities under the logistics group commander. These were Air Mobility Command (AMC), ATC, Air Force Special Operations Command, the Air National Guard, and the Air Force Reserve Command.

Two other major changes took place in the 1990s that would not impact the objective wing structure directly but would introduce new considerations to the conduct of maintenance on a broader scale. The first was the formation of the Air Combat Command on 1 June 1992. The distinctions between tactical and strategic aircraft were blurred by operations in Vietnam (bombers doing tactical missions). During Desert Storm, the Secretary of the Air Force, Chief of Staff, Vice Chief, and TAC and SAC commanders all spearheaded the drive to integrate the assets of SAC and TAC into a single operational command. At the same time, MAC reorganized by consolidating airlift and most refueling assets under a single umbrella, the new AMC. AMC provided the *global reach* facet of the Air Force mission, while the new ACC provided the Air Force's *global power*.[47]

The second change was the formation of the expeditionary air force (EAF) in response to both an evolving world situation with popup contingencies in places where the Air Force had rarely operated before and continuing steady-state regional security commitments far from any Air Force main operating base. The organizational aspects of the transition to the EAF resulted in the designation of ten air and space expeditionary forces (AEF) that rotate their availability for deployment and rapid response on a periodic basis. This required the establishment of a global system of CONUS support locations, forward support locations, and forward operating locations (FOL), all of which have affected maintenance operations in that units at FOLs are supported much the same way as squadrons at forward bases were supported during the Gulf War.[48] The relatively autonomous CAF flying squadron under the objective wing was seen as conducive to EAF and AEF operations.

In February 2002, General John Jumper, Chief of Staff of the Air Force, put together a working group to examine a standardized wing organizational structure. The purpose of the working group was to present a new wing and group organizational structure designed to meet the needs of the AEF. Jumper, as well as other Air Force senior leaders, had determined that an organizational restructure was needed to improve combat readiness and enable the Air Force to focus on its core disciplines.[49]

On 25 March 2002, Jumper and the MAJCOMs approved the new combat wing organization structure. On 22 April 2002, Jumper sent out a message via the Defense Messaging System informing Air Force personnel of this new, standardized wing structure.

The new wing structure consists of four groups: the operations group, maintenance group, mission support group, and medical group (Figure 1). Their responsibilities are as follows:

- **Operations Group.** Operations group activities will focus on planning and executing air and space power.
- **Maintenance Group.** Aging fleets and years of resource shortfalls require increased attention to the balance of sortie production and health of our fleet.
- **Mission Support Group.** The Air Force will develop a career path for commanders who understand the full scope of home-station employment and sustainment and deployment, beddown, and sustainment at contingency locations: crisis actions, force protection, unit type code preparation, load planning, communications, en route visibility, reception, contracting actions, bare base and tent city preparation, munitions site planning, personnel readiness, expeditionary combat support, and so on.
- **Medical Group.** Medical groups will continue to focus on maintaining a fit and ready force.[50]

Conclusions

Throughout its history, the Air Force has moved between centralized and decentralized, standardized and MAJCOM-varied maintenance organizations, often in response to changes in budgets, resources, and technology. Transformation is likely to continue, and organizations will likely continue to evolve to support changing mission requirements within current resource constraints.

Notes

1. *Air Service Plan of Supply, Salvage, and Repair*, Memorandum No 37, Aug 18.
2. Royal D. Frey, "Evolution of Maintenance Engineering," Vol 1, unpublished historical study, AMC, Wright-Patterson AFB, Ohio, Jul 60.
3. Army Air Forces, War Department Circular 65-11, *The Air Corps System of Maintenance,* Washington DC, 5 Apr 29.
4. Capt James N. Townsend, "A History of Aircraft Maintenance in the Army Air Forces and United States Air Force," Research Report, Air Command and Staff College, Maxwell AFB, Alabama, 78, 19.
5. Townsend, 20.
6. Townsend, 21.
7. *Production Line Maintenance Manuals*, Patterson Field, Ohio, Headquarters, Army Air Forces, 15 Feb 44.
8. Ernest W. Spitzer, Readings and Seminar, Command and Management, Vol 5, "Maintenance in the US Air Force," Air Command and Staff College, Maxwell AFB, Alabama, Dec 77, 328.
9. Townsend, 27.
10. Lt Col Thomas E. Reiter, "USAF Aircraft Maintenance Organizational Structure: Where We've Been, Where We Are, What's the Future," Research Report, Air War College, Air University, Maxwell AFB, Alabama, Apr 88, 5.
11. Col Edmund J. Borowski, "The Suitability of the USAF Aircraft Maintenance System for Total War," Air War College, Air University, Maxwell AFB, Alabama, 1952, 49.
12. Col Richard J. Fry, "Aircraft Maintenance, A Limiting Factor in the Strategic Air Command," Air War College, Maxwell AFB, Alabama, 1957, 7.
13. "Berlin Airlift, A USAFE Summary, 26 Jun 48—20 Sep 49," unpublished resume of Berlin Airlift, USAFE, 16–17.
14. *Ibid.*
15. Townsend, 28.
16. Borowski, 51.
17. Townsend, 32.
18. Carl G. Nelson, "REMCO: A Korean War Development, Air War in Korea," Vol VIII, *Air University Quarterly Review*, Vol VI, No 2, Summer 1953, 78–85.
19. Townsend, 35.
20. Fry, 9.
21. Air Force Regulation 66-1, *Maintenance Engineering*, Department of the Air Force, Washington DC, 30 Dec 53, 1.
22. Capt George D. Benjamin, "An Analysis of Aircraft Maintenance Management within Air Weather Service", Research Study, Air Command and Staff College, Air University, Maxwell AFB, Alabama, 1965, 11.

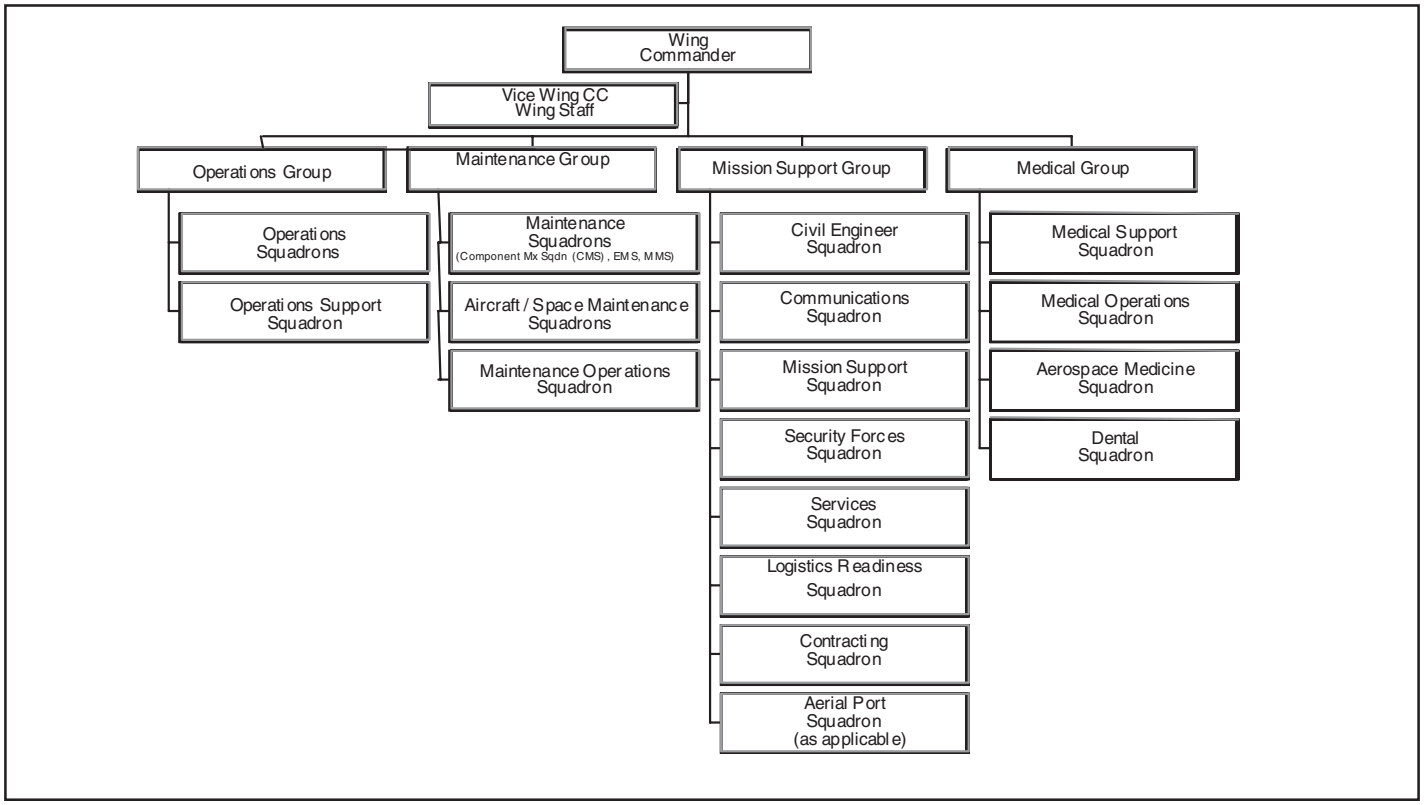


Figure 1. Combat Wing Organization[50]

23. Lt Col Thomas P. Foss, *The Logistics of Waging War*, Air Force Gunter AFS: Alabama, Air Force Logistics Management Center, 1983, 151.
24. Benjamin, 12.
25. Capt Wesley C. Davis and Capt Sanford Walker, "A Comparison of Aircraft Maintenance Organizational Structures," master's thesis, AFIT/GLM/LSM/925-16, School of Systems and Logistics, Air Force Institute of Technology, Air University, Wright-Patterson AFB, Ohio, Sep 92, 126.
26. US Air Force, Tactical Air Command Manual 66-31, Maintenance Management, Headquarters, Tactical Air Command, Langley AFB, Virginia, Aug 66.
27. Ronad G. Slaunwhite, "Squadron Maintenance," *TAC Attack*, Aug 66, 13.
28. "USAF Personnel Strength—1907 Through 1968," *Air Force Magazine*, May 87, 79.
29. Maj Logan J. Bennett, 3.0: A Look at Constraints on Achieving Three Turns (Daily) Using F-4 Aircraft, Briefing for CINCUSAFE, DCS/Logistics, 1974.
30. US Air Force, AFM 66-1, "Chief of Maintenance (Aircraft and Missile)," *Maintenance Management*, Vol 2, Washington DC, 1 Aug 73, Foreword.
31. Reiter, 18.
32. Project Streamline, HQ USAFE, DCS/Logistics, Directorate of Maintenance, Nov 73.
33. Maj Gen William R. Nelson, "POMO—A New Concept," *Aerospace Safety*, Mar 77, 3.
34. Maj Norman J. Beu and Maj Richard C. Nichols, "More Maintenance in OMS," Research Study, Air Command and Staff College, Air University, Maxwell AFB, Alabama, May 77, 78.
35. Capt Dwight J. Foster and Capt John C. Olsen, "A Comparative Evaluation of the Effects of the Implementation of the Production Oriented Maintenance Organization (POMO) on Aircraft Maintenance," master's thesis, LSSR 27-785, School of Systems and Logistics, Air Force Institute of Technology, Air University, Wright-Patterson AFB, Ohio Sep 78.
36. Foster, et al, 110.
37. Capt Barbara L. Harris, "Challenges to United States Tactical Air Force Aircraft Maintenance Personnel," master's thesis, AFIT/GLM/LSM/915-28, School of Systems and Logistics, Air Force Institute of Technology, Air University, Wright-Patterson AFB, Ohio, Sep 91, 19–20.
38. Harris, 150.
39. Reiter, 30.
40. Reiter, 26.
41. Dr Eliot Cohen, *Gulf Air War Power Survey*, Vol III, Logistics and Support, Department of the Air Force, DS79.724.U6G95, 1993, 61.
42. Cohen, 308.
43. Cohen, 311.
44. Cohen, 332.
45. Capt Wesley C. Davis and Capt Sanford Walker, " A Comparison of Aircraft Maintenance Organizational Structures," master's thesis, (AFIT/GLM/LSM/925-16) School of Systems and Logistics, Air Force Institute of Technology, Air University, Wright-Patterson AFB, Ohio, Sep 92, 21 and 126.
46. "Air Combat Command History," 2002 [Online] Available: http://www2.acc.af.mil/library/history.
47. Paul S. Killingsworth, et al, "Flexbasing: Achieving Global Presence for Expeditionary Aerospace Forces," MR-1113-AF, RAND Corporation, 2002, xvii.
48. Air Force Working Group, "New Air Force Wing/Group Organizational Structure," working group paper, Feb 02.
49. Gen John Jumper, Chief of Staff Message transmitted via Defense Messaging System, 22 Apr 02.
50. "New Air Force Wing/Group Organizational Structure."

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notable quotes

Army officers are intelligen—give them the bare tree, let them supply the leaves.

—General George C. Marshall

Current
Logistics Research

AFMC Plans and Programs Logistics Analysis

Richard A. Moore

There is nothing permanent except change.

— Heraclitus

If you are an Air Force logistician, you know change is part of the business. Operational scenarios change, logistics policies change, and information systems change. The list of changes is endless. The challenge logisticians face is managing the risks associated with changes. If we know tomorrow's world will be different from today's, how do we posture the Air Force logistics process to provide world-class support to the warfighter?

That is the question that drives much of the work of the Air Force Materiel Command (AFMC) Management Sciences Division. We are operations research analysts who use our formal training in applying mathematics and modeling to add clarity to decision-making processes in an ever-changing world. As part of the AFMC Directorate of Plans and Programs, we do more than just logistics analysis.

Following is a summary of three of our significant 2004 spares management studies and a list of other contributions made to help Air Force logisticians deal with change. You can request a printed or electronic copy of our 2004 annual report from Samantha Hetrick (937-257-3887 or samantha.hetrick@wpafb.af.mil).

COLT Implementation at the Base Level—Cost Neutral Readiness Improvements

Which spare parts should the Air Force supply system stock to meet demands from maintenance? If we knew exactly which parts were going to be demanded and when and if we knew how long it takes to receive the parts from suppliers, this would be a trivial problem. But with the uncertainties of the real world, none of this information is known with 100-percent confidence, so it is advisable to use optimization algorithms that determine which parts to stock to minimize back orders based on the variability of these processes. This is what Customer-Oriented Leveling Technique (COLT) does for parts supplied by the Defense Logistics Agency (DLA). COLT is an inventory-level computation system we developed and enhanced over the last 3 years. After the tremendous successes from implementing the program at the air logistics centers (ALC), we worked with Headquarters Air Force Installations and Logistics and the Air Force Logistics Management Agency to export this capability to bases.

Air Combat Command (ACC) nominated Seymour Johnson AFB, South Carolina, to begin a pilot in October 2003, and Air Mobility Command (AMC) nominated Travis AFB, California, to begin a pilot in November 2003. We worked closely with ACC and AMC in 2004 to conduct and monitor the results from the pilots, while improving the COLT model as we learned more about the base environment. The results we saw at the two bases mirrored the success we saw at the depots (Figures 1 and 2).

MICAP hours decreased by 62 percent at these bases 10 to 11 months before using COLT to 11 to 12 months after COLT started. We are confident that these results are attributed mostly to COLT because neither base saw similar performance improvements in non-COLT parts and similar bases did not see the same performance improvement for the COLT parts. It also should be noted that these improvements came about with no increase in spares cost.

As a result of these successes, we will be exporting COLT to other bases in 2005:

- ACC: Ellsworth AFB, South Dakota, and Nellis AFB, Nevada
- Air Force Reserve Command: Homestead ARS, Florida, and Minneapolis-St Paul ARF, Minnesota
- Air Force Space Command: Peterson AFB, Colorado
- Air National Guard: Selfridge ANGB, Michigan
- Pacific Air Forces: Elmendorf AFB, Alaska; Kadena AB, Japan; and Kunsan AB, South Korea
- United States Air Forces in Europe: Keflevik, Iceland, and Spangdahlem AB, Germany

Because of our work on COLT and other efforts aimed at improving spares support to the warfighter, we were recognized, along with Headquarters Air Force Materiel Command (AFMC) Logistics, in receiving the Supply Chain Council Award for Supply Chain Operational Excellence in the Department of Defense category.

Alternative Forecasting Techniques for Low-Demand C-5 Items—Can Longer Demand History Improve Forecast Accuracy?

In an earlier article, we highlighted how to optimize stock to deal with the uncertainty in forecasting demand. But are there better methods for forecasting demands so that stock levels can be optimized further? Demand forecasting is always difficult, but it is even more troublesome for parts that break very infrequently. In 2001, a C-5 Tiger Team was established to identify policies that could improve logistics support to the C-5 weapon system. The team hypothesized that using forecasting techniques, which apply more than 2 years of historical usage data might produce improved forecasts for parts that fail less frequently than once in 2 years. Based on this initial recommendation, we were asked to review the impact of the following proposed policy: continue to compute rates and factors in the Secondary Items Requirements System (D200A) using 2 years of data unless there had been no usage in the last 2 years; if there was no usage in the last 2 years, then use up to 6 years of usage history to compute rates and factors.

We evaluated the forecast accuracy from the current forecasting technique, which is an eight-quarter moving average, and various alternative forecasting techniques with the 6 years of data:

- Exponential smoothing with four different smoothing parameters (0.5, 0.3, 0.2, 0.1)
- Twenty-four-quarter moving average

The results indicate that the current approach is as accurate as any of the others, and it is much less volatile. But this does not measure the impact on the warfighter. So we extended the analysis to determine the practical benefits of implementing the new technique in D200A and weigh those against the cost of implementing the required system changes in D200A. To accomplish this, we examined the impact of using the new technique on the spare-part stock levels computed by the aircraft availability model (AAM) in D200A. We also analyzed the correlation between the list of affected parts and the list of parts that have caused C-5 MICAPs since January 1999 to determine if the parts with infrequent demand have truly been *problem parts*.

This analysis showed the new forecasting technique would cause AAM to compute a stock level of at least one for each of the affected parts, whereas using an eight-quarter moving average, the current approach, would cause AAM to compute a stock level of zero. Although on the surface it seems as though these increased stock levels would improve the aircraft availability of the C-5 weapon system, further analysis indicates the actual benefit would be somewhat limited. This is caused by most of the affected parts already having serviceable assets on hand. As a result, increasing the stock level would have little to no impact on actual performance. Furthermore, we found relatively little correlation between the affected parts with infrequent demands and the list of parts that have caused a MICAP on the C-5 since January 1999. Specifically, only 38 of the 208 affected parts have caused a MICAP during the period examined. Of these 38 parts, the performance of only 5 could be improved through an increased level because they had no assets on hand (serviceable or unserviceable).

As a result of this analysis, we recommended that, although the performance of this small handful of parts could be improved by implementing the new forecasting technique, it would be more cost effective and would accomplish the same result to categorize these parts as numerical stockage objective (NSO) items within the current requirements computation system. The business rules prescribed in this study can be applied to identify the NSO candidates.

Impact of Using Realistic Shop Flow Times in the Computation of Spare Part Requirements

A key input to the D200A process for computing spares requirements for the Air Force is the amount of time it takes the depots to repair a part. If it takes longer to repair a part, more spares are required to buffer the warfighter from delays. The computation process historically has used *standard* flow days, which are engineering estimates for how long it should take to repair parts if all repair resources were immediately available in the repair shops. An integrated product team, consisting of members from the Ogden ALC and AFMC Management Sciences Division completed a study showing large differences between standard depot repair times and actual shop flow times obtained from the Inventory Tracking System (ITS). We then analyzed the impact on budget and performance when actual depot shop flow times are used.

We evaluated three scenarios in the analysis:

- A *base line* scenario, using standard shop flow times to compute spares requirements to weapon system *specific aircraft availability targets.*
- *A limited funding* scenario, using the dollars computed in the base-line run. The objective is to compute the aircraft availability from spending the same amount of money as in the base-line run but change the mix of parts by using actual shop flow times in the spares computation.

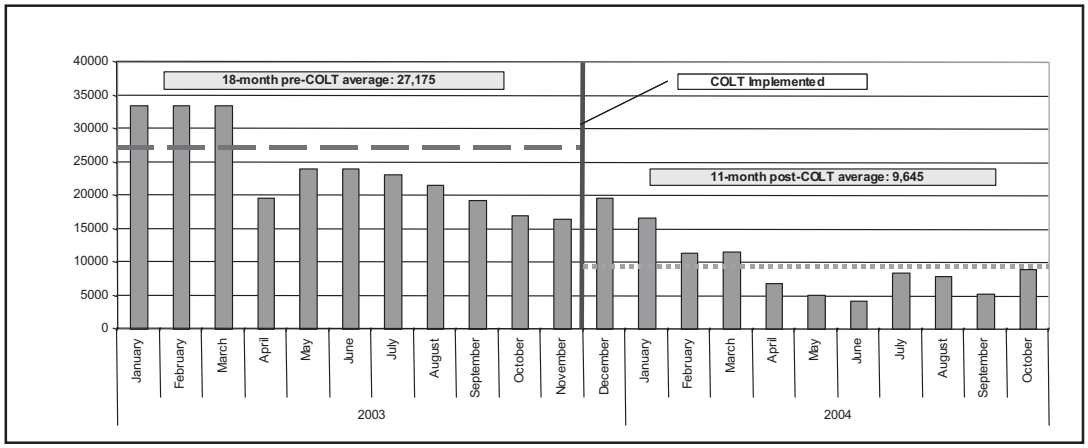

Figure 1. COLT Item MICAP Hours at Seymour Johnson AFB

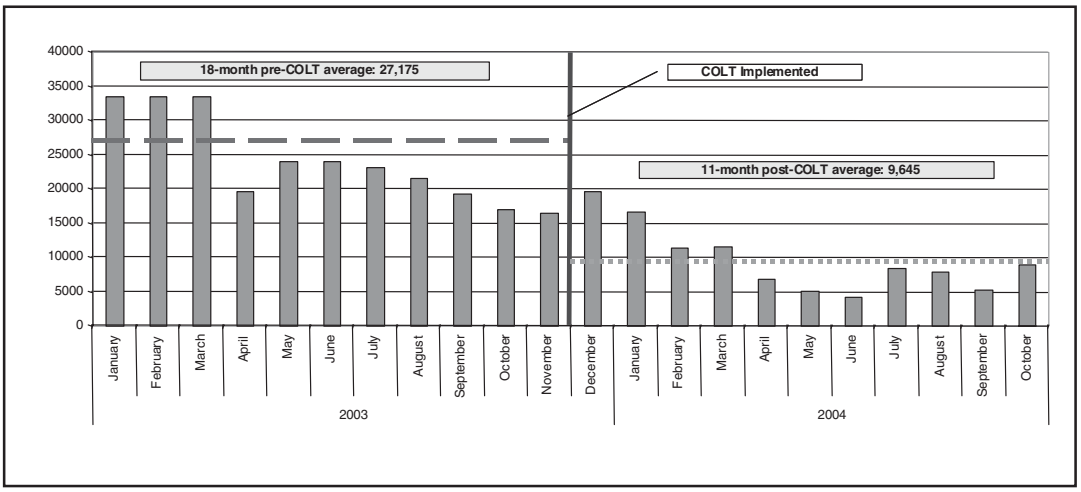

Figure 2. COLT Implementation at Travis AFB

- A *full funding* scenario using the actual shop flow times to compute spares requirements to weapon system specific aircraft availability targets.

The difference in availability between the limited funding and base-line scenarios is the expected no-cost performance improvement. The analysis showed that an 18-percent increase in aircraft availability can be achieved—at the same cost—by using actual shop flow times. The full funding scenario also showed that it would cost approximately $450M to fund the spares requirement fully with the actual shop flow times. We briefed this analysis to Headquarters AFMC Logistics who approved implementation of actual shop flow times in the March 2004 D200A computation.

Later, we assisted Headquarters AFMC Logistics with implementation of actual shop flow times in the March and September D200A computations. We obtained 2 years of ITS transactions from each air logistics center to calculate average shop flow times and filtered outliers as appropriate. We then provided these shop flow time values to the AFMC Spares Requirement Branch to be applied in the D200A computation.

Other Contributions

We helped improve how Air Force logisticians manage uncertainty in a number of additional ways in 2004. Following is a brief summary of our most significant efforts, grouped into four functional areas:

- Performance Measurement
  - Showed that actual performance of reparable spares at the air logistics centers is much worse than planned performance because of understating cycle times for spares during planning processes.
  - Discovered that Air Force demand prediction processes significantly overpredicted and underpredicted spares requirements to support Operation Iraqi Freedom.
  - Built a prototype feedback process to evaluate the prediction of wartime demands.
  - Showed that transferring materiel distribution responsibilities to the Defense Logistics Agency would increase the Air Force spares budget by $30M for each additional day of delay in shipping times.
  - Created a prototype tool to compute supply chain metrics objectively.
  - Identified F-15 subsystems with the highest failure rates to help reduce functional check flight failures during programmed depot maintenance.
  - Provided quantitative results indicating cannibalizations and other workarounds are essential to achieving required warfighter support when the supply chain is constrained by shortfalls in funding or performance.
- Logistics Planning
  - As part of a source selection team, produced various documents and data to be used in the acquisition of an advanced planning and scheduling system.
  - Participated in activities of the strategic planning and balanced score card teams as a full-time member of the Purchasing and Supply Chain Management Integrated Product Team.
  - Began an analysis to determine optimal DLA and Air Force stockage policies.
  - Computed updated spares performance targets that were implemented in D200A.
  - Provided a methodology for determining the economic benefits from improving spare part reliability, which ultimately led to the successful justification for engineering funding.
  - Assisted with the integration of legacy readiness-based math models into the Advanced Planning System demonstration at Oklahoma City ALC.
  - Identified the impacts on sustainment costs of potential force structure changes.
  - Began an investigation into how to better predict the variability in demands for spare parts.
  - Continued building a long-term, archival database of inputs and processing results of both the Air Force and DLA Weapon System Support Programs (WSSP).
  - Provided tools and analysis support for the implementation and ongoing operation of the Air Force WSSP workbench module.
  - Conducted 30 separate studies to address data and process issues associated with the Air Force WSSP.
- Allocating Logistics Resources
  - Continued supporting the implementation of COLT at the air logistics centers, which has resulted in a 56-percent reduction in customer wait time.
  - Used COLT to execute $128M in end-of-year funding at the depots.
  - Completed test and evaluation of the revised aircraft sustainability model that the Air Force uses to compute readiness spares package (RSP) stock levels for aircraft components needed in war.
  - Assisted at the June 2004 RSP workshop, helping to train Air Force personnel who establish inventory levels and manage readiness spares packages.
  - Participated in meetings with wartime supply chain modeling experts to focus on potential improvements to RSP models for capability assessment and requirements computation.
  - Conducted analysis and recommended that the Air Force revisit the decision to implement the inventory efficiency pilot at Oklahoma City and Ogden ALCs.
  - Provided quarterly analysis reports to Headquarters AFMC Logistics senior management to use in approving the implementation of the readiness-based leveling stock levels.
- Executing Logistics Processes
  - Prioritized depot maintenance repair shops according to their impact on the warfighter, which led to a base-line deployment plan for implementing lean manufacturing principles at the depots.
  - Provided analyses to the Air Force Supply Wartime Policy Working Group that showed the Execution and Prioritization of Repair Support System prioritizes RSP requirements equitably with other spares requirements.
  - Validated logic in Recoverable Assembly Management Process for identifying broken parts to evacuate from bases.
  - Began an analysis effort using simulation to reengineer the technical order process.

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(Inside Logistics continued from page 28)

maintenance work contracted out to the private sector has been significant as the private sector is contracted to do about half the work needed. It is commonly referred to as contract repair. Responsibility for the material sent to contractors for repair lies with AFMC, the three Air Force inventory control points, DLA, and repair contractors. Repair contractors are obligated to repair parts within a specific period and to report asset status weekly. Contractors use the Air Force legacy system (G009) to report end-items status, usually via manual data entry at the contractor facility. This is the only way to convey to the Air Force the contractor inventory picture once repair items have left the Air Force depot to be repaired at a contractor site. Government users, however, see the available data in G009 as unreliable because they often are outdated, incomplete, and inaccurate because of the long update cycle and manual nature of the inputs. Providing status data can be time consuming to the contractor and expensive for the Government, although the cost of this manual data input is included in the cost of repair. Item managers and production management specialists are forced to rely on regular telephone calls to the contractor to check on the progress of needed repair items.

Availability of contract repair parts impacts the availability of the weapon systems, which, in turn, impacts mission capability. During Operation Iraqi Freedom, there were shortages of spares and repair parts needed by deployed forces. To mitigate such a shortage and continue to carry out the mission, units resorted to cannibalizing vehicles or getting around normal supply channels to keep equipment in ready condition. Item managers need timely and accurate data to provide realistic delivery dates to customers. They need to spend less time chasing information and more time managing items to meet customer needs. They need visibility into the supply network that they are supporting so they can assess, analyze, and modify plans. This would allow them to sense and respond adequately to demands.

As it stands, resolving issues can be time consuming—confusing at best—and take supply chain professionals away from planning repairs and providing their customers with quality support.

Trends: The Power of Visibility (Why Change the Process?)

The Air Force is striving to achieve greater collaboration with its supply base to obtain greater connectivity and interoperability of logistics system, enabling the timely ordering, tracking, and delivery of supplies through the pipeline. One of the priorities, not only for the Air Force but also for the whole of DoD, is to create a common operating view and improve data quality. Knowing the health of one's network allows for better planning, execution, and flexibility. In industry, companies such as Hewlett-Packard Enterprise have enforced Zero Latency Enterprise whereby integration of real-time data and business processes across the enterprise support real-time actions. A benefit is a decrease in order cycle time by enhancing real-time visibility of inventory. This sort of visibility is exactly what the DoD is looking for. In a recent General Accounting Office report, "Defense Logistics: Preliminary Observations on the Effectiveness of Logistics Activities During Operation Iraqi Freedom," it was found that asset visibility and other logistics systems were not fully interoperable and data were not entered into asset visibility and other logistics systems in a uniform and consistent manner.

To better achieve asset visibility of items in repair, the DoD has adopted the Commercial Asset Visibility (CAV II) program developed by the Navy Supply Information Systems Activity (NAVSISA) to track depot-level repair items at a commercial contractor site. This program is Web-based and provides the commercial repair contractor direct access through the Web to the Navy or Army CAV II system to enter repair status. The contractor receives immediate validation feedback on data entered. For those contractors that maintain an internal mainframe system to track assets at their facility, entering data in the CAV Web system and their internal tracking systems causes them to perform double entry of repair transactions into two tracking systems with the possibility of data entry errors causing the two systems not to match on status.

A Pilot In Motion: Picking Up on Trends

The Navy and the Army currently use the CAV II system that provides visibility of items undergoing repair in commercial contract sites. As AFMC is adopting CAV II, contract repair items handled at the air logistics center (ALC) will be phased out of G009 and transitioned into the CAV II system.

To assist in alleviating the double data entry and provide the Air Force item manager better visibility, less errors, and increased data visibility on a timelier basis, the CRISP pilot program focused on using XML technology to transmit repair transaction data directly from the contractor software system through DAASC to an Air Force test site, resulting in a single data entry at the contractor site.

The CRISP Development Team built an XML schema and business object documents and connected the Air Force ALC at Warner Robins to Rockwell Collins in Cedar Rapids, Iowa, via DAASC. The nature of the transactions was receipts, inductions, completions, shipments, and any reversal actions of those four transaction types, if necessary. Because CAV II was not yet in use, a test application was built to view asset status, as well as a few other practical reports (flow days report and a production management specialist report). The reports allowed users to see what had been received to date at the contractor and what had been inducted, completed, and shipped to date. The application was updated every hour from the contractor systems. The pilot did not depend on any manual data entry whatsoever. The data are fed automatically to the test application via XML from the contractor internal tracking system. The test scope was of one contract, with four contract lines and four different stock numbered end items for repair.

A Trend Put to the Test: Benefits (Lining Up with Air Force Expectations)

Since CRISP used a Web-based XML language to interact with the contractor system, it has the capability to transmit updated repair status on a near real-time basis when the contractor updates its internal system. It provides timely status to the item managers and production management specialists. This fact alone alleviates the many telephone calls required by the item manager to check the status of a repair and, in addition, provides additional repair data related to changes in repair turnaround time and awaiting parts conditions.

CAV II currently provides contractors much the same capability of sending repair status directly from their internal systems to CAV through the CAV EDI program, which utilizes the EDI ANSI X12 language set. The difference between EDI X12 and XML is twofold. EDI X12 is very costly to implement at a

contractor site and is difficult to learn, resulting in a lengthy development and implementation cycle. Although the Navy uses EDI ANSI X12, only three contractors have been willing to underwrite the high cost of implementing the ANSI X12 technology. In addition, X12 transactions are processed through the Navy Ecommerce System in an end-of-day batch environment only, not interactive to CAV directly as XML would be. XML development at Rockwell Collins during the CRISP pilot took only a short time to develop and implement, all at a low cost (1300 hours at a cost of $100 per hour). The XML implementation is not dependent on volume of contracts or items repaired but represents the efforts to implement the protocol itself.

Pilot Impact: Why Is this Stuff Important, Why Does It Matter? What Has this Pilot Done?

So what is the impact of employing XML technology to contract repair parts supply? For one, it offers the Air Force and, possibly, DoD an incredible opportunity to institutionalize contract repair visibility across its supplier base, enabling the creation of a dynamic support network. While it is not equivalent to the magical snapping of the fingers, it offers some real power to logisticians: the power of information, giving logisticians a long, hard look into the networks they manage so they can better plan and respond to the unusual.

The team found that the item managers and the production management specialist were using G009 only on a monthly basis to figure out what happened for the previous month. To compensate for the limitations in G009, the Air Force worked with the contractor to provide supplemental repair status data in a weekly spreadsheet. This spreadsheet and CRISP were comparable because they each referred to individual serial numbers, and this made it easy to know what was accounted for and what was not.

The CRISP pilot was evaluated for technical performance and business impact. The business impact considered both the operational benefit and cost justification. Furthermore, items in the pilot were evaluated in terms of their issue and stock effectiveness, customer wait time, funded undelivered status, back-order status, and flow days. Users expected that enhanced visibility would yield significant operational benefit. Although there may have been some improvement in customer wait time, back orders, and mission capability (MICAP) hours, the pilot period of 4 months was insufficient to observe significant operational benefits. Actual flow-day reports are not presently available in G009. They are made available to the Air Force on a weekly basis for this specific contract via the supplemental spreadsheet discussed above. The pilot for CAV-XML offered actual flow days computed on each depot-level reparable being repaired, from the day it was received at the contractor to the day it was shipped. It also tracked days in work thus far, allowing item managers and production management specialists to act and communicate with contractors when days in work were approaching contracted flow days.

The analysis of flow days showed that, for all items on which work had been completed and which had been shipped back, as many as 45 percent had exceeded contracted flow days. Through discussions with the item managers and production management specialists, it was apparent that communication is crucial for these items. Indeed, the information manager and the production management specialist want to know what is holding up these items and what is the updated forecasted ship date. The pilot definitely raised Air Force staff awareness by providing increased visibility.

The pilot team had anticipated the number of funded undelivered to decrease under the influence of CAV-XML. The degree to which the item manager could rely on the CAV-XML would allow for more frequent ordering of lesser quantity, thus decreasing funded undelivered and speeding up the cash flow cycle. The short duration of the pilot did not allow seeing how future orders could be impacted.

CAV-XML informed the Air Force when an item on an order was completed and shipped. The visibility afforded in the project allowed supply chain managers to have a more accurate view of their supply and to update their system with that transparency.

Customer wait time and issue effectiveness were expected to be impacted where days in work were approaching contracted flow days. Item managers, as well as production management specialists, were able to have enhanced visibility and had the opportunity to take action to minimize the item's turnaround time, but both remained an issue throughout the duration of the pilot as the repair parts supply process was subjected to real external constraints. With CRISP, the Air Force could verify near real time what items had been received at the contractor against the order and make sure all items were received. This allowed indirect shipment monitoring by the Air Force.

From the flow-day analysis, one stock number (and its interchangeable national stock number) made up for 54 percent of late items. This was consistent with MICAP hours for the same stock number. The report for MICAP showed some improvements throughout time. The data also indicated that MICAP hours could be caused by longer than contracted flow days.

Total asset visibility is not quite magic yet, but it allows the ability to determine the cause of problems with more ease even if it does not necessarily lead to a solution to the problem. Access to flow days allows the Air Force contracting offices to have measures in hand and to meet with their suppliers to discuss options available to them. The pilot allowed the Air Force to see the state-of-the-inventory picture. Equipped with that knowledge, Air Force logisticians have the potential to better respond to the customer and better collaborate with suppliers.

So, if there is a clear logistics advantage to access to timely and accurate information, is there an equal economic advantage as well? The pilot team carefully examined the cost of employing this technology against the cost of its alternatives. Was it worth it, or was this tech tool too cost prohibitive?

The cost model for the business case considered three alternatives. The first alternative was CAV II, where updates are no longer weekly but daily and where manual data entry at the contractor is still the way of life. The second alternative was CAV II-XML, enabled by CRISP technology with the elimination of manual data entry at the contractor, and near real-time update of information. The third alternative was CAV-EDI, enabled by EDI with near real-time update, no manual data entry at the contractor, but a substantial cost to implement.

The cost model for the business case accounted for several cost categories:

- Air Force cost of searching for information
- Implementation costs for each alternative
- Contractor cost of responding to Air Force search for information
- Contractor cost of reporting item status.

Other elements were taken into account such as discount rates and penetration rates, which consider the proportion of contractors that are likely to adopt and implement the solution,

and a time line of 3 years to compare the cost of the different solutions identified.

The cost categories were considered across the three possible alternatives. All costs usually are passed to DoD, either as direct charges or embedded in overhead rates or prices. The costs associated with developing the remaining message formats needed for full operational deployments were included in these costs.

The cost analysis shows that adding XML capabilities to CAV II is much less expensive than adding EDI capabilities, with essentially the same benefits. The benefits of adding XML or EDI to CAV II come from the reduction in labor, specifically at the contractors, as data entry is automated and as item managers and production management specialists make fewer calls to contractors to find out about the status of parts in the repair process. These reductions amount to a cost avoidance that is much greater than the cost of implementing CRISP, whereas in the EDI case, the implementation costs are high enough to eliminate any savings for more than 3 years.

Twenty-eight contractors were identified as good candidates to implement the XML capability. These 28 contractors represent 90 percent of the total Air Force transaction volume, 66 percent of the depot-level reparables, 8 percent of contractors, 3 percent of contracts, and 2 percent of the Air Force contracts' total value. There always will be some companies that resist change or will not be able to implement XML capability. Because the Air Force will expect and pay for the contractor to obtain such capability, 90 percent of the 28 contractors identified as good candidates are likely to proceed with an XML implementation. The Air Force would not have to pay for manual data entry any longer. Some Air Force contractors outside the 28 identified may have enough transaction volume with the DoD to justify the implementation of CAV-XML. The Air Force also may be interested in automating the reporting process with some of the remaining contractors as part of its effort to enable asset visibility and create a sense-and-respond logistics force.

In summary, over the 3-year time line, CAV II would cost about $92M, CAV-XML would cost about $66M, and CAV EDI would cost about $93M. The most significant savings for the CAV-XML solution are in the labor costs of manual data entry and information search and response.

Trend: A Reality?

Some of us who may have had the experience in working with these types of pilots realize there is a tendency to relax once success has been demonstrated and that things seldom progress into actual production status. Unless a strong focus is maintained, the work accomplished for the pilot never will be applied to support day-to-day operations.

Not the case here. The power of information not only is well publicized but also is pervasive in many areas of our lives. Air Force users are ready for this technology. When a trend is supported by its acceptance, concrete benefits, and a real cost advantage, it persists and infiltrates all the de facto standards by which society operates.

CRISP demonstrated a *win win* when the Government and industry share information and make a good business case for each. The CRISP connection worked, and the Air Force plans to adopt it. Item managers expect to be able to better support the warfighters. The success of CRISP is expected to spawn other opportunities for government-industry information sharing under the Deputy Director for Supply Management at the Directorate of Logistics for Headquarters AFMC, Edward C. Koenig III directive.

A technical configuration meeting was held in Mechanicsburg, Pennsylvania, where a technical interface overview took place to describe the process to transition CRISP technologies into production CAV II. The Air Force is now working with the CAV Team on an implementation strategy and time line.

Currently, repair contractors are paid for reporting requirements using the Air Force application G009. Rockwell Collins and other pilot contractors report that the loss of reporting revenue is not significant and that it would not be a barrier to adopting direct connections with their government customers. They do not see the reporting as desirable work and are more interested in developing new ways to support their customers. They are also interested in reducing the support costs associated with responding to queries from production management specialists.

Contractors also are interested in business process consistency across contracts and DoD customers. CRISP provides an opportunity for a common method of reporting repair status that is consistent across all military services. While the cost of automatic reporting is significantly less than the cost incurred when relying on manual methods, there are costs associated with configuration and maintenance of the information technology systems that perform the function. It would be helpful for contractors to have a consistent funding model that can be applied routinely to contracts with automatic repair-status reporting requirements. For the CAV-XML alternative, the service funds the contractor for automatic data reporting. Contractor costs primarily are associated with establishing the capability for automatic XML reporting, setting up new contracts, and operational status reporting. While many funding strategies are possible, the CRISP Team suggests a cost recovery strategy where the contractor is funded separately to establish and operate automatic status reporting for each contract.

Transitioning a Pilot

The CRISP solution can be deployed at various levels. These levels range from narrow use of CRISP to provide the Air Force with enhanced access to repair status information to broader application of CRISP, where the CRISP approach would be used to share additional information with repair contractors or where other services would utilize CRISP-initiated XML transaction sets for contractor repair status. For each of these uses, a champion is needed to promote adoption of the CRISP solution.

Headquarters AFMC is championing the use of CRISP for better Air Force access to contractor repair status information. The ALCs are the most immediate beneficiaries of this improved access and would promote adoption of CRISP technology to their repair contractors. AFMC would serve as the technical point of contact to facilitate direct connections with contractors. Core to this support is AFMC's adoption of the CAV-XML interface (the CRISP software component) as an operational component of the CAV application. AFMC and the air logistics centers are motivated to champion CRISP to provide better support for their respective customers. Transitioning this pilot into a production system involves the role of DLA DAASC as the common interface between contractors and DoD information systems. DLA DAASC is the appropriate organization to own the XML transactions, perform routing to appropriate application sites, and execute mapping between specific formats. DAASC is positioned to encourage other services to use the CRISP XML transactions and

processing methods. DAASC will *own* the CRISP transaction definitions and is motivated to champion CRISP as part of its mission to encourage common DoD adoption of best electronic commerce approaches.

Pilot and Lessons Learned

Developing new technology and evaluating it in a live pilot, with many organizations participating, is always a challenge and this project was not an exception. There are several areas for lessons learned from this pilot. The first area is the dilemma of data synchronization. The CAV-XML approach requires government databases to be synchronized with contractor databases. Methods are needed to verify and correct differences. The pilot encountered several data synchronization issues. One issue was related to initializing databases at startup. Another issue was propagating changes to the participants. Finally, there was a need for data, tools, and analysis to determine if there were problems and to troubleshoot problems for resolution. The second area is the area of security. Issues around security can arise, and a backup plan can be helpful. To mitigate these issues, the architecture must be flexible; the DAASC role was most helpful. In this case, DAASC was ready to start the routing process for the pilot when new government orders were issued that prevented access through the DAASC firewall. The CRISP architecture was flexible enough that routing could be achieved through ICF Consulting while the Air Force would work with DAASC on authorizing actions for transactions routing. The third area concerns user interface. CRISP is information-sharing technology that is nearly invisible to the end user. When CRISP is doing its job, the data in CAV II are more timely and accurate, but CAV looks the same. This background capability is hard for users to evaluate. In this case, a test application was needed to provide users access to the information being shared with CRISP. Users tend to focus on the user interface, which in a pilot evaluation can never be as functional or mature as a production product. The lesson learned is to avoid, wherever possible, prototype user interfaces. Last, the area of supply chain performance seems to make Headquarters Air Force part of the solution. Metrics were tracked and observed. Users recognized the value of the pilot that afforded them an enhanced view of operations in a timely fashion, but the pilot application itself did not resolve supply chain performance issues. Visibility encourages measuring the supply chain network and enhancing collaboration between supply chain partners to resolve performance issues. Visibility does not solve supply chain performance but gives the visibility to empower organizations and people to do so.

Conclusion

Central to the idea of the next steps for CAV-XML is the idea of supplier collaboration and total asset visibility. The DoD has released directives for serialized item tracking and use of radio frequency identification (RFID), as well as unique identifier tracking. These components can be enabled easily and accommodated by XML by allowing an RFID field, serial number field, or an identifier field to be tracked and communicated and to exist within the schemata and document type definition.

Collaboration is a two-way street whereby the DoD and the Air Force can better communicate their needs to the supplier, from the point of forecasting repair to communicating repair priority and point of need (customer and customer location). This will be important in specifically linking government and contractor information systems so each has direct access to information that was previously held internally and only released intermittently as reports.

Some of the possible areas where CRISP technologies could be applied are the DD-1348, "DoD Single Line Item Requisition System Document," issue/release document, and automated packing list. These are provided to the contractor with the unserviceable depot-level reparables for repair. Often, it is the receipt of these physical unserviceable units that is the first indication to the contractor regarding repair. The lack of advanced notification to contractors limits their ability to plan and better meet the needs of their government customers. Contractors have suggested that they could better plan if they were to get an electronic copy of the DD-1348 when it is issued.

Another applicable area is repair priority notification. The virtual Internet Communications Protocol integrated management across the three air logistics centers generates a prioritization list of items every day for organic repair, using the Execution and Prioritization of Repair Support System. There has been an effort within AFMC to provide a similar prioritization for contractor repair. This initiative was suspended, in part, because of data currency problems in legacy systems with contractor repair production counts. Use of CRISP should improve the quality of contractor production data, so restarting this effort may be appropriate.

The DSC Contract Repair Information System Protocol Project took on a longstanding problem and examined several possible solutions. CAV-XML was put to the test, and the pilot proved that XML transactions are fully functional and can be relied upon. CAV-XML offers a tangible solution to the lack of visibility into the contractor repair cycle. The Air Force plans to adopt CAV-XML and is actively working with NAVSISA to plan its deployment. Funding has been identified to move forward. CRISP was an excellent project that proved the ability to cost-effectively transfer data between contractors and the Government. Rockwell Collins, as other repair contractors, is looking forward to future opportunities that will further reduce manual data input, improve data integrity, and improve data timeliness. This pilot is one of the small steps taken by DoD, specifically the Air Force, toward transformation, enabling supply chain visibility and reaping its benefits. That journey promises to be much longer and marked by numerous progresses in technology that are oftentimes applicable to supply chain networks.

In preparation for Air Force implementation of CAV II, ICF Consulting is assisting AFMC by converting all CAV II EDI transactions into an XML standard approved by the DoD for logistics transactions. This effort will be completed by July 2005.

Notes

1. Office of Force Transformation, Operational Sense and Respond Logistics: Co-evolution of an Adaptive Enterprise Capability, Concept Document (Short Version), 2004.

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AIR FORCE JOURNAL of LOGISTICS

Volume XXVIII,
Number 4
Winter 2004

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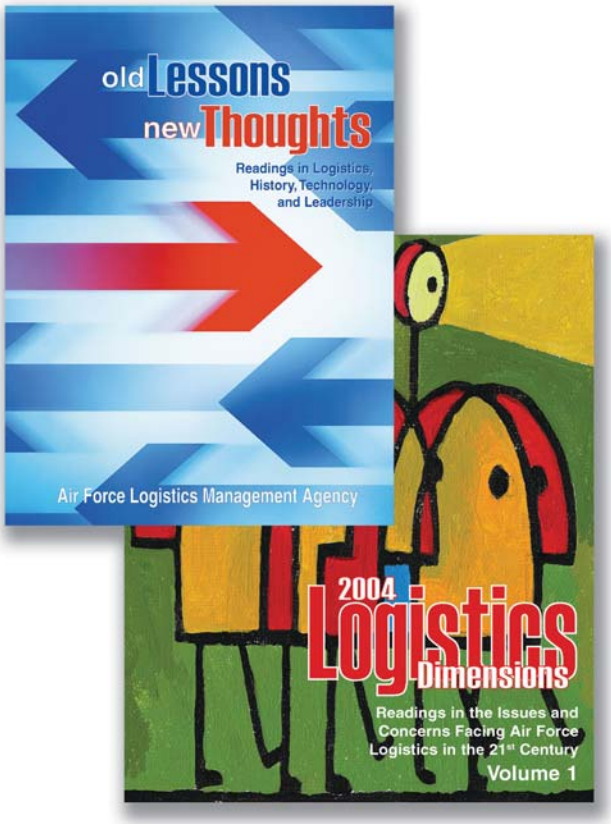

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