



The F-15 Eagle's Silver Anniversary

U.S. AIR FORCE



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FRONT COVER: An F-15E During an Initial Flight Test. BACK COVER
TOP: An F-15E Launches an Advanced Medium Range Air-to-Air Missile.
BACK COVER BOTTOM: An F-15 Prepares to Leave the Chocks.

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Development and Analysis of a Dual-Role Fighter Deployment Footprint Logistics Planning Model

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Research into the sizing of a deployment package for a new weapon system development (hereafter referred to as the "footprint") supports our ability to deploy combat forces into the next century. The Joint Strike Fighter (JSF) is the next-generation, multi-service, multi-national dual-role fighter acquisition program focusing on the development, testing, and fielding of a replacement aircraft for aging air-to-ground fighters such as the Air Force's F-16 and the Marine Corps' AV-8 Harrier. We developed a deployment footprint model for the JSF and analyzed the effects of Design and Technology Advances (DTAs) on the future footprint of the JSF weapon system. This paper documents the creation of a point estimate linear equation and a spreadsheet model for deployment footprint analysis and provides three example applications of the spreadsheet model for the JSF. The result is a point estimate of the total footprint which can then be used as justification during trade studies. Although the model described here has a direct application in the JSF acquisition process, this research serves as a proof of concept for modeling any future weapon systems deployment footprint. (9) This model also has some utility for the A-10, F-117, F-15, and F-16 Program Managers and/or Chiefs of Logistics when looking at the deployment footprint of their systems.

Introduction

Changing world events since the end of the cold war have caused the US military to dramatically change its mode of operations. Before the downfall of the Soviet Union, the US military projected its power through a policy of forward presence. Military bases spread around the world served notice that America was committed to maintaining a stable world order. Starting in 1990, the US Air Force adopted the goal of "Global Reach, Global Power." (11) In response to this changing policy, then-US Air Force Chief of Staff General Larry D. Welch stressed the importance of flexible forces able to rapidly deploy around the world with minimal support and resupply. (3)

The military today finds itself in a period of declining airlift assets and, even with the C-17 coming on line, the US is still deployment-constrained by airlift availability. (4, 8) Airlift constraints will always exist, but reducing the size of future deployment footprints today is one way to reduce the impact of these restraints and is key to force projection in the future. The size of tomorrow's deployment package is affected by systems in acquisition today and the decisions made in their design.

Very little attention has been given to the building block of the process—the size of the package to be moved. Presently, deployment footprints are accepted at the end of a weapon system

development as impossible to affect, when in reality this can be addressed as a performance measure up front. This disparity results in a developing aircraft system, such as the JSF, being forced to manually estimate the deployment package.

Management Implications

Historically, 95% of all weapon system logistics are baselined by the completion of the Program Definition and Risk Reduction Phase. (14) If it were possible to analyze various design options from the perspective of the deployment footprint, trade-offs could be made early in the design of future aircraft and dramatic reductions made in the deployment footprint. As a tool, this new deployment footprint model will provide an input into the trade-off analysis process, as opposed to the footprint being considered an afterthought.

Literature Review

Military mobility planning and execution ranges from humanitarian operations to the projection of combat power. (12) Planning for military operations takes many forms and usually involves the use of models to test a planned course of action. Most deployment models analyze the primary constraint in the military force projection today—airlift. The use of mobility models allows military planners to study potential scenarios without the associated cost.

Joseph Brierly, in "Overview of Logistics Modeling," describes six categories of models and modeling techniques: deterministic modeling, stochastic modeling, algorithmic models, optimization, artificial intelligence, and simulation. (2) Each of these techniques and methodologies was created to minimize the cost associated with decision making.

Deployment operations currently rely on several systems to perform the aforementioned modeling. At base level, each wing is required to prepare deployment load plans using the Computer-Aided Load Manifesting System. (5) This system pulls equipment data into a model of the interior of any number of airlifters and allows for the rapid response of a unit when tasked to move the preplanned package. A second base-level system for modeling is the Automated Mobility Schedule of Events (AMSOE). AMSOE permits the scheduling of an entire deployment timeline, for any number of support airlifters, with any combination of arrival and departure times. Another modeling tool, the Contingency Operation/Mobility Planning and Execution System (COMPES), allows individual units to tailor the standard deployment package to fit the unique requirements of their unit. (6) At the major command and joint staff level, other

models simulate the setting up and maintaining of a specific capability.

The mobility-related models typically address movement issues, such as how to schedule and move combat forces to support a major regional conflict. Little attention is given to the building block of the process—the size of the package to be moved. The problem with each of these deployment models is their inability to modify the footprint being moved. Existing models simply deal with the deploying organizations movement requirement. To date, no model has been developed to relate the early stages of aircraft development to the deployment footprint they will command upon delivery. Because system designs are most easily modified in the early phases of a program, this is also the time when deployability issues should be aggressively pursued. (10)

Research Methodology

Phase One

Phase One of this research applied the concepts of linear regression to current aircraft systems to create a point estimate for the total package weight, or number of personnel versus the number of aircraft deployed. We collected personnel and equipment data on standard Air Force deployment packages from six operating weapons systems (including the Aviation and Intermediate Level Maintenance (ILM) unit type codes (UTCs)). We then completed a regression of personnel and equipment requirements against various sizes of aircraft packages.

Phase Two

In Phase Two we collected data from the COMPES logistics detail on the 18-primary authorized aircraft (PAA) packages for select weapon systems. This data was used to create a deployment footprint model showing the relative contribution of each category of equipment to the total package. The developed model allows for the selection of a baseline aircraft and the manipulation of configurations to show relative changes in the deployment footprint.

Phase Three

Based upon the model developed in Phase Two, three JSF DTAs were analyzed and their effects upon the deployment footprint determined.

Assumptions

Data was restricted to independent, active duty, non-composite wing, non-quick-response UTCs with the following data sources approved by the JSF Program Office: F-16C/D (Block 30), F-16 Low Altitude Navigation and Targeting Infrared for Night (LANTIRN) (Block 40), F-16 High Speed Anti-Radiation Missile (HARM) (Block 50), F-15E, F-117A, and the A-10 Aviation and ILM UTCs. Variables of interest in this model include the use of PAA as the independent variable in the linear regression analysis (Phase One), and the coding used in Phase Two of the research (Table 1). The dependent variable for the regression analysis is either the cumulative weight of equipment or number of personnel in the combined Aviation and ILM UTCs. The codes used in Phase Two were created in order to logically break the cargo into a smaller number of groupings and were

approved by the JSF Program Office and then reviewed by the primary JSF weapon system contractors.

Aviation Unit Type Code (UTC) Categories (CAT) and Sublevel (SUB) Categories		
CAT	SUB	TITLE
SE—Support Equipment	AIR	SE-Air
	COL	SE-Cooling
	CRY	SE-Cryogenics
	GEN	SE-General
	HET	SE-Heat
	HYD	SE-Hydraulics
	JAK	SE-Jacks
	LIT	SE-Lighting
	LUB	SE-Lubricants
	PWR	SE-Power
	STD	SE-Stands
	TOW	SE-Towbars
AR—Armaments	GEN	AR-General
	JAM	AR-Jammers
	RAK	AR-Missile Racks
	TRL	AR-Trailers
	UAL	AR-Universal Ammunition Loaders
TE—Test Equipment	AVI	TE-Avionics
	GEN	TE-General
	HYD	TE-Hydraulics
	SEN	TE-Pod Mounted Sensors
SP—Spares	ENG	SP-Engines
	RSP	SP-Readiness Spares Package
	TIR	SP-Aircraft Tires
	TNK	SP-Drop Tanks
FS—Flightline Maintenance	GEN	FS-General
VE—Special Purpose Vehicles	AGE	VE-Aerospace Ground Equipment Support/Bobtail
	GEN	VE-General
	TOW	VE-Aircraft Towing
OP—Administrative, Intelligence, and Operations	ADM	OP-Administrative Support
	CLA	OP-Classified and Intelligence
	GEN	OP-General
	LIF	OP-Life Support
Intermediate Level Maintenance UTC CAT and SUB Categories		
CAT	SUB	TITLE
IL—Intermediate Level Maintenance	ACC	IL-Accessories
	AGE	IL-Aerospace Ground Equipment
	AVI	IL-Avionics
	ECM	IL-Pod Mounted ECM
	FUL	IL-Fuel Cell
	GEN	IL-General
	JET	IL-Jet Engine Shop
	PWR	IL-Power Supply
	STD	IL-Stands

Table 1. Model Categorization Codes

Predictions

This deployment footprint model fills a void in the link between new weapon system acquisition and deployment planning. The use of a future-oriented footprint analysis during the early stages of acquisition planning allows trade-offs to accommodate reduced footprint limits or demonstrate to decision makers where footprint limits are unrealistic, given proposed designs.

Model Description

This model allows aircraft developers to create an intended aircraft—from a deployment configuration perspective—by selecting data from existing aircraft of similar subsystem designs, then “piecing together” a deployment footprint estimate of an intended aircraft. Where no direct comparisons exist, the model allows the data to be increased or decreased by operator-derived percentages.

Once the data is selected, the model calculates either the weight, square footage, or cubic volume of the deployment package and segregates the quantity as either in support of the Aviation or ILM portion of the deployment package by major categories and subcategories. The model provides users with the flexibility to create an aircraft baseline close in design to the envisioned aircraft without limiting the model manipulators in their data selection. The spreadsheet model is too large to display in this publication in its entirety. Figure 1 below is representative of the structure of the model.

Research Questions and Findings

What is the relationship between the number of aircraft deployed and the deployment footprint and how does that

quantity change with an increased number of deployed aircraft? Regression analysis reveals that the relationship between the number of aircraft deployed and the deployment footprint can be modeled linearly. The conclusion of a linear relationship is the result of performing a linear regression on 13 combinations of Aviation and ILM UTCs using PAA as the independent variable.

Personnel

$$\text{QUANTITY OF PERSONNEL} = -15.955 + 22.542(\text{PAA})$$

Adjusted R-Square¹ of .8432

Equation 1

Equipment

$$\text{CARGO (In Short Tons—2,000 Pound Units)} = -21.712 + 17.477(\text{PAA})$$

Adjusted R-Square of .8276

Equation 2

This question provided insight into the relative increase in deployment footprint size as the number of aircraft increases. The

¹ Adjusted R-Square represents “a convenient measure of the success of the regression equation in explaining the variation in the data” (7) with the adjustment taking into account the number or variables used in the model. The Adjusted R-Square represents how good your model is, with 1.0 being perfect. The Adjusted R-Squares above of .8432 and .8276 signify the equation very effectively explains the variation in data.

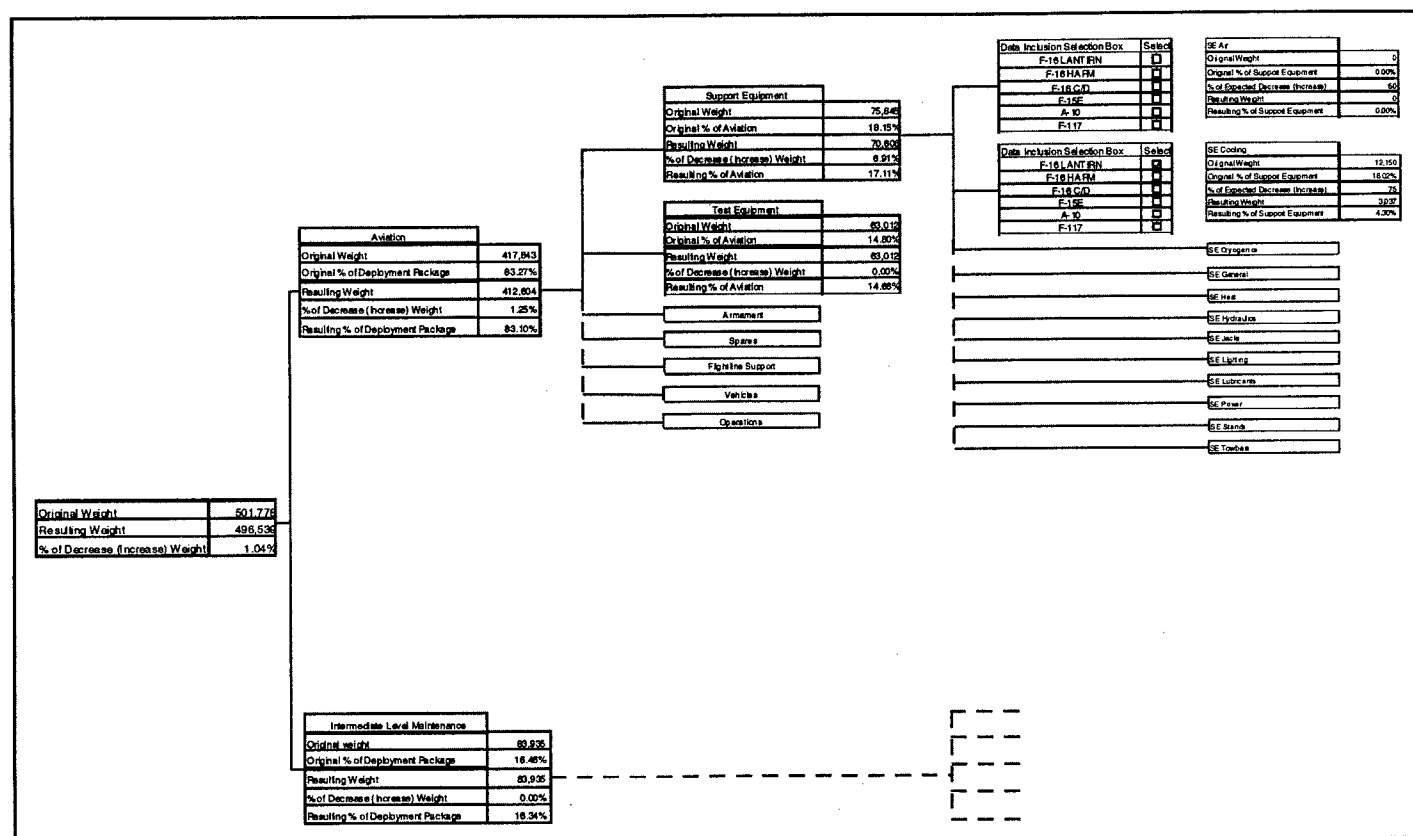


Figure 1. Sample Deployment Footprint Model

per aircraft increase for personnel is 22.542, with a p-value² less than .0001. This slope is statistically significant over the range of 8 to 24 aircraft. Similarly, for cargo the per aircraft increase in weight is 17.477 short tons (also significant with a p-value less than .0001). For the JSF projected 18-PAA package, this equates to a point estimate of 384 personnel and a weight of 585,600 pounds. Using the conversion factor of 45,000 pounds per C-141, this equates to just over 13 C-141 equivalent loads (disregarding personnel space and baggage requirement).

Can a deployment footprint model be developed for the JSF and what areas of greater concentration of equipment does the model identify that could be reduced by design trade-offs, resulting in a smaller deployment footprint? Our research proved the concept of modeling a deployment footprint for a developing weapon system. This specific model allows for the use of any of six different data sets as a baseline to model the future deployment footprint subject to any modifications envisioned for the JSF. Due to the flexibility built into the model, the specific category of equipment, which is the largest contributor to the overall footprint, varies according to the weapon systems chosen as the data sources for the intended baseline.

What are the effects of projected DTAs on the deployment footprint of the JSF aircraft? The analysis was done on three notional, but likely, advances based upon the JSF baseline, the F-16 (Block 40) with LANTIRN.

Onboard Oxygen Generation System

Installation of an onboard oxygen generator would eliminate the need for containerized oxygen servicing of the aircraft. In the model, the liquid oxygen (LOX) cart is included in category Support Equipment (SE), Cryogenics (CRY), or SE-CRY. For the baseline aircraft selected, the F-16 LANTIRN, SE-CRY also includes liquid nitrogen servicing and hydrazine servicing. For this reason the analysis assumed a 50% reduction in SE-CRY with the following results:

- Original Weight: 16,445 pounds, representing 14.81% of all SE.
- Resulting Weight: 8,222 pounds, representing 7.99% of all SE.

This resulted in a 1.81% reduction in the Aviation UTC total weight, and a 1.53% decrease in the weight of the total package.

On-Board Power and Cooling Systems

Installation of systems to provide a self-starting power supply and the capability to provide conditioned air during maintenance could result in the elimination of three categories of Support Equipment, SE-PWR (Power), SE-COL (Cooling), and SE-HET (Heat). Reduction of these items by 100% reduces the weight of the deployment package by 50,575 pounds, and represents a 45.53% decrease in the support equipment contribution to the Aviation package. This translates to an 11.16% decrease in the weight of the Aviation UTC, and a 9.42% reduction in the weight of the total deployment footprint.

Advanced Ground Support Equipment

Armstrong Laboratory at Wright-Patterson AFB, Ohio, is conducting research on advanced ground support equipment in a program called the Multifunction Aerospace Support System (MASS). (1) This piece of aerospace ground equipment (AGE) will combine six or more pieces of AGE into a modular unit. The net effect (if developed, fielded, and utilized) is the elimination of SE-PWR (Power), SE-LIT (Lighting), SE-AIR (Air), SE-COL (Cooling), SE-HET (Heat), SE-HYD (Hydraulics), TE-HYD (Test Equipment-Hydraulics), and a 50% reduction in SE-CRY (Cryogenics), for the aforementioned LOX carts. MASS is in development and is estimated to weigh 2,000 pounds when fielded. With a basis of issue of one for every two aircraft (total of 9 for 18-PAA), MASS could eliminate 99,632 pounds of cargo while adding 18,000 pounds in "new" weight. The net effect is an 18.12% reduction in the Aviation UTC and a 15.21% reduction in the total deployment footprint (based on weight).

Conclusions

Significance of Research

Deployment footprint modeling provides a link between the acquisition process and the actions necessary to estimate the size of a deployment package as the system is developed. The JSF Program Office is at a point in the development of the next generation dual-role fighter where a tool such as the deployment footprint spreadsheet model can link current decisions directly to the impact on deployment footprint. Recognizing that weapon system acquisition is an iterative process where trade-offs are made based upon current and future impact, this tool will provide a means of comparing DTAs envisioned for the JSF to the impact on the deployment footprint.

Application

Current airlift planning factors call for the ability to move between 49.4 and 51.8 million ton miles per day (MTM/D) to support "a major regional conflict (MRC) closely followed by a second MRC where the enemies' attacks are stopped prior to achieving essential objectives. The attacks are stopped by the rapid delivery of halting forces composed of in place, prepositioned and airlifted forces. In order to stop the enemy and then counterattack, it is essential to rapidly deploy reinforcing units to the theaters. The heavy equipment and supplies for these forces must be moved by sea and the troops and critical high value materiel by air." (13)

Given the ability to model the deployment footprint for a developing weapon, and the constraints and criticality of airlift, let us analyze the effect of altering the deployment footprint in the acquisition process as it pertains to combat power projection. The concept is to show trade-offs between cost, performance, and deployment footprint can lead to systems capable of greater force projection. The comparison will involve a hypothetical weapon system representing a future fighter aircraft and its ability to support combat operations.

The acquisition process starts with the identification of a need to address a specific deficiency. For this example the deficiency is the inability to neutralize a potential adversary's military capabilities within its own borders. One means of addressing

² The likelihood the equation you are using passed the test for usefulness, but is in fact not correct.

this need is through the application of explosive ordinance delivered by an aircraft directly onto the target.

The ability to render a target ineffective is the result of numerous factors, but boils down to the availability of the munitions and the availability of the delivery platform—in this case an aircraft. Only the acquisition of the delivery platform will be discussed in this scenario. The acquisition and capabilities of the explosive ordinance will be treated as a given constant with respect to performance. If we assume the following list of requirements, then a comparison of cost, performance, and deployment footprint could reveal the best mix of these performance measures. All of this has been greatly simplified and is for example purposes only.

- Number of Targets: 1,000.
- Probability of Kill (PK) for the Aircraft/Munitions System: 0.8.
- Baseline Sortie Rate: 2.0/Day.
- Deployment Footprint for 18-PAA Squadron: 12 C-141 Equivalents (~300 tons).
- Distance to Forward Operating Location: 7,500 Miles.
- Airlift Availability Constraint: 50 Million Ton Miles Per Day (MTM/D).

For analysis purposes, the number of targets, distance, and airlift constraint are to be treated as constants. Based on the number of targets and the PK, there is a requirement for flying a total of 1,250 sorties, and with a sortie rate of 2.0, this could be accomplished with 625 aircraft days. If 11.25 MTM/D (22.5% of the available lift for the required movement period) were allocated for the movement of air-to-ground fighter aircraft squadrons, then five squadrons of these aircraft could be put in place to go against these 1,000 targets. This baseline results in 90 aircraft on the ground, flying for just under seven days (6.94 days), and consuming 22.5% of the available airlift for the required movement period.

Based on the model developed, what would happen to this baseline if a system such as MASS was integrated into the fighter aircraft? From a deployment footprint perspective, the required airlift per squadron would decrease by 15%, for a reduction of 45 tons and taking the total to 255 short tons per squadron. Given that the airlift constraint remains constant at 50 MTM/D, this allows for two options. First, by reducing the individual fighter squadron deployment footprint, the airlift allocation for air-to-ground fighter movement could be reduced to 19.13%, effectively freeing up 1.6 million ton miles of airlift. Second, using the same 22.5% airlift allocation, the Air Force could now put 5.88 squadrons on the ground in the same time. That equates to almost 16 more aircraft, which would kill the same 1,000 targets in 5.89 days—a full day sooner.

This same logic is easily—and commonly—applied to the trade-off of performance measures such as aircraft/munitions PK versus sortie rate and/or cost. The inclusion of deployment footprint in these trade-offs could have similar consequences. If we assume the 15% reduction in deployment footprint, what could you do to the PK and/or sortie rate if the seven-day flying scenario was found acceptable?

In this case, you would have been able to deploy the additional 16 aircraft for a total of 106, operating for seven days against 1,000 targets. If you held the sortie rate constant at 2.0, then the required PK for the aircraft/munitions combination could go down to just over 0.67. This could open the options for greatly reduced cost for the system based on the new “required” PK to meet the same combat objectives. Another option is to hold the PK constant at 0.8 and derive a new sortie rate. This turns out to be 1.68, which again could drive back cost requirements during acquisition while providing the same combat punch.

Research and Model Limitations

Certain facets of the research effort and model were limited, but to the greatest extent possible all efforts were coordinated with the JSF Program Office and operational units. Following is a summary of these limitations.

Data Accuracy

The development and maintenance of UTCs is an on-going process controlled by operational bases. It is possible the data used in this model has become obsolete due to on-going updates by the UTC pilot units.

Data Entry

The entire process was a learning experience with respect to equipment classification. Differing opinions on equipment functionality may have led the two primary authors to classify a piece of equipment of similar function, but from different data sets, into conflicting CAT- or SUB-groupings.

Flight Line Maintenance Category

The FS-GEN category (essentially the support section in a deployed environment) was created after the data reduction phase of the research had significantly progressed. The large quantity of flight line maintenance equipment accompanying their deployment packages initially led to the creation of over 20 classifications of the FS category. Adding to this problem was the fact some aircraft deployment packages provided no indication as to what this class of material was used for, whereas others provided the detail allowing the creation of the 20-plus SUB-categories. As a result of these factors, the FS category was not broken out below the CAT level.

Model Internal Dynamics

When the model is loaded with a proposed aircraft's deployment data there would be a benefit if the model integrated the relationship between subsystems of the aircraft. If the model were robusted to integrate these interactions, then single point changes to the model would automatically derive related subsystem changes.

This research proved the concept of deployment footprint modeling and showed direct application to the JSF. Follow-on research might look at duplicating some or all of this research from a weapon subsystem functionality perspective versus the maintenance organization classification used. Additionally, the model could be expanded or tailored to include other weapon systems.

Summary

This research revealed a very dynamic deployment planning environment and concluded two things. First, the research showed deployment footprint modeling can be accomplished at the operational level. Secondly, the spreadsheet model developed provides an additional means of analysis for the JSF as the Program Office weighs trade-offs during weapon system development. This model proves the concept for follow-on efforts by other developing weapons systems, but does not—and cannot—provide an operational tool for any organization other than the JSF due to the data selected.

The model developed by this research effort will allow the JSF Program Office and weapon system contractors to conduct deployment footprint trade-off analysis during the developmental phases of this program. This capability should elevate deployment footprint analysis from an afterthought in the acquisition process to a driving force behind acquisition decisions. Although this model applies specifically to the JSF, the concept has implications for future weapons systems and could provide some utility to already fielded fighters.

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Best Article Written by a Junior Officer

The Executive Board of the Society of Logistics Engineers (SOLE) Chapter, Montgomery, Alabama, has selected "Applying Neural Networks to Demand Forecasting" (Summer-Fall 1996), written by Captains Mark A. Abramson, USAF, and Harry A. Berry, USAF, as the best *Air Force Journal of Logistics* article written by a junior officer(s) for FY96.

Environmental News

Re-refined 15W40 Motor Oil in Accordance With Mil Spec MIL-L-2104 Is Now on Contract

The Defense Supply Center Richmond (DSCR) has awarded a re-refined 15W40 oil contract to the Gard Corporation, of Kansas City, Kansas. This oil is procured in accordance with Military Specification (Mil Spec) MIL-L-2104, and contains a minimum 25% re-refined base stock. It meets the American Petroleum Institute (API) CD and CD-II [see Editor's footnote] performance levels and has been qualified by the Army's Mobility Technology Center-Belvoir, Fort Belvoir, Virginia.

Used engine oil contains contaminants which are picked up during use, as well as components of the additive package. The re-refining process, which consists of vacuum distillation and hydrofinishing, removes these contaminants and additives to produce a "new" base stock; thereby, allowing the oil to be reused.

Re-refined Mil Spec 15W40 engine oil is available to all military and federal customers. Three national stock numbers (NSNs) may be ordered via Military Standard Requisitioning and Issue Procedures (MILSTRIP) or Federal Standard Requisitioning and Issue Procedures (FEDSTRIP) as indicated below:

NSN	Unit of Issue	Viscosity	Price
9150-01-421-1427	One Quart Bottle*	15W40	\$ 1.16
9150-01-421-1424	Five-Gallon Can	15W40	\$ 18.80
9150-01-421-1432	55-Gallon Drum	15W40	\$174.12

* Must be ordered in multiples of 12 (case load quantities only).

This oil is designed for use in all combat and tactical, diesel and gasoline powered, ground vehicles and equipment, and includes performance requirements for power shift transmissions. This 15W40 re-refined oil may also be used in many hydraulic, power steering, power transmission, and gear box applications, as specified by the lube orders.

The 15W40 Mil Spec oil is on a Direct Vendor Delivery (DVD) contract, so the oil is fresh and shipped directly from the manufacturer's plant to your door within 30 days (for overseas customers, delivery may take slightly longer). And, for your

CD and CD-II are both API service categories for diesel engine oils. The CD service category is for diesel engine service. This category denotes service typical of certain naturally-aspirated, turbocharged, or supercharged diesel engines in which highly effective control of wear and deposits is vital or in which fuels of a wide quality range, including high-sulfur fuels, are used. Oils designed for this service were introduced in 1955 and provide protection from bearing corrosion and high-temperature deposits in these type of diesel engines. The CD-II service category is for severe duty two-stroke cycle diesel engine service. This category denotes service typical of two-stroke cycle diesel engines that require highly effective control of wear and deposits. Oils designed for this service also meet all performance requirements of API service category CD.

convenience, there is no minimum order quantity for these DVD deliveries.

On 20 October 1993, President Clinton signed the Executive Order on Federal Acquisition, Recycling, and Waste Prevention. This Executive Order urges agencies to buy environmentally preferable products or products made with recovered materials. Re-refined oil is such a product. Upon signing this Executive Order, President Clinton stated:

Families, businesses, and communities all across America know that recycling makes sense. It saves money and it protects the environment. It's time for the Government to set an example and provide real leadership that will help create jobs and protect the environment, encouraging new markets for recycled products and new technologies.

According to the United States Environmental Protection Agency (EPA), Americans who change their own oil throw away 120 million gallons of recoverable motor oil by dumping it on the ground, pouring it down storm drains, or putting it in trash cans. Recycling this motor oil would save the United States 1.3 million barrels of oil per day.

According to The "Buy Recycled" Training Institute, every ten days the equivalent to the EXXON Valdez spill occurs over the mainland of the US during routine oil changes. Re-refining creates the most responsible demand for used oil, while reducing irresponsible dumping.

Re-refined oil meets all the warranty requirements for diesel equipment manufacturers. For a copy of the statements by Cummins, Detroit Diesel, and/or Caterpillar, call the number listed at the end of this article.

Buying re-refined oil and recycled used motor oil makes sense. It saves the environment, conserves our nation's resources, and supports legislation signed by the President.

For more information on these products and a copy of the new 1997 DSCR Motor Oil Brochure, contact Ms Robin Champ at 1-800-345-6333, (804) 279-4908, DSN 695-4908, or e-mail at rchamp@dscr.dla.mil. You can also visit our Internet Home Page at <http://www.dscr.dla.mil>.

DoD Shelf-Life Item Management

Incurring high disposal costs from your hazardous shelf-life materiel? Shelf-life materiel going to waste in storage? There is a new Department of Defense (DoD) resource that will help you to manage shelf-life materiel? The Defense Logistics Agency (DLA) Operations Support Office (DOSO) will show you how to properly manage these items and train your personnel to reduce disposal costs by using the M-204 Program.

Have you heard of the M-204 Program? If not, you are not in step with the rest of DoD. DOSO is providing a two-day course in DoD Shelf-Life Management to include hands-on computer instruction via on-line access to the DoD M-204 Program. The training also provides DoD policy information on how to properly manage your shelf-life materiel at the inventory control point/source of supply (ICP/SOS) and distribution levels.

Call DOSO now to request training for your activity or to sign up for one of the classes being taught at the Defense Supply Center Richmond, Virginia, on 3-4 Jun 97 and 9-10 Sep 97. This training is guaranteed to provide your site with the most current DoD policy information and the latest technology resources used to manage shelf-life materiel. Contact Gilbert Ruffin at DSN 695-5224, Karen Wolfe at DSN 695-5212, or Pam Hagan, DSN 695-3880 (Commercial access for all phones is (804) 279-xxxx).

Cleaning Agents for Signature Control Material Installation and Repair

Naval Surface Warfare Center, Carderock Division (NSWCCD) has completed a comprehensive laboratory evaluation of technically acceptable, less hazardous alternative solvents to the ozone-depleting substance, 1,1,1-trichloroethane (TCA), as a cleaning agent for signature control materials prior to adhesive bonding.

Seven candidate solvents were identified for testing. Criteria established to aid in the selection of candidate solvents required each solvent to

- 1 Pass an environmental, safety, and health review and administrative toxicity assessment
- 2 Clean as well or better than TCA, and
- 3 Leave no undesirable residue that would adversely affect adhesive bond strength.

CDNSWC prepared the passive countermeasure system and shipboard acoustic treatment specimens in accordance with Standard Material Application Procedures and cleaned them with the candidate solvents, to evaluate the cleaning ability and resulting residue of each. CDNSWC determined the effect of the cleaner on the adhesive bond strength by measuring the linear peak, maximum, minimum, and average stresses of each specimen. CDNSWC also conducted a cost-benefit analysis to compare the direct and indirect costs and assess the economic impact of each candidate solvent.

CDNSWC found four solvents now available through the Federal Stock System to be technically acceptable alternatives for TCA for surface preparation procedures during the installation and repair of signature control materials:

- For passive countermeasure system materials: Breakthrough, PF-145HP High-Performance Degreaser, Positron, and PF Degreaser; and
- For shipboard acoustic treatments: Breakthrough, PF-145HP High-Performance Degreaser, and PF Degreaser

Here are the national stock numbers (NSNs) for the alternative solvents: [See table above in next column.]

Reprinted from *CFC ♦ Halon News*, Dec 96. Article by Mary Wenzel, US Navy NSWCCD, DSN 287-5245 or (301) 227-5245, e-mail: wenzel@metals.dt.navy.mil. These and many other products are listed in the Defense Logistics Agency (DLA) Environmental Products catalog. Point of contact: Stephen Perez, DSN 695-6054 or (804) 279-6054, e-mail: sperez@dscr.dla.mil.

Solvent	NSN	Unit of Issue
Breakthrough	6850-01-378-0666	55 gallons
	6850-01-378-0698	15 gal
	6850-01-378-0679	5 gal
PF-145HP	6850-01-377-9360	55 gal
	6850-01-377-9710	5 gal
	6850-01-378-0044	6 gal (1gal/container)
PF Degreaser	7930-01-328-4058	55 gal
	7930-01-328-2030	5 gal
	7930-01-398-1027	3 gal
	7930-01-328-5690	6 gal (1gal/container)
Positron	6850-01-412-0028	55 gal
	6850-01-412-0026	6 gal
	6850-01-411-8815	1 gal

Shaw AFB Saves \$60K and Wins Governor's P2 Award

How much are a few rolls of paper towels worth? For Shaw AFB, [South Carolina,] they were worth more than \$60,000 and a Governor's 1995 Pollution Prevention Award.

How did Shaw AFB turn paper towels into cold cash and a prestigious honor? First, it determined its largest hazardous waste stream: the cleaning solvent used to degrease aircraft, vehicle, and aerospace ground equipment parts. The vats used to clean the parts contained PD-680 Type I, a hazardous petroleum distillate-based solvent that had to be changed every three weeks as it became contaminated with metals from the parts.

After Shaw AFB identified its largest hazardous waste stream, it set out to eliminate the waste. Gulf Coast Filter Company from Mississippi designed a filter unit that was installed on several test cleaning units. Rolls of paper towels or toilet paper served as the low-cost, low-maintenance filters in these units. The filters remove the metal particles from the solvent so it can be reused over and over. At the same time, the base switched to the use of a nonhazardous cleaning solvent.

Shaw AFB personnel then tested the new system. Because the Armament Flight cleans all weapons used on all aircraft assigned to the base, it generates the largest amount of waste solvent annually. The results of the waste reduction effort were astonishing. Before the new filter systems were installed, the Armament Flight alone spent \$21,300 each year to purchase solvent, and another \$19,800 to dispose of the contaminated solvent. In contrast, the new filter system cost \$3,800 to purchase and only \$300 a year to operate. The new filter system paid for itself in only 71 days; therefore, the flight saved \$33,100 the first year (1995), with savings estimated to be \$40,800 yearly after that. These numbers provided the justification for replacing an additional 32 vats with new filter units. Combined, these units resulted in a reduction of another 8,000 gallons of solvent yearly, for a savings of about \$21,000.

The filter system has resulted in a 98 percent reduction in hazardous waste at Shaw AFB. The base has used the same nonhazardous solvent for two years and has not needed to replace it. (The filters will be replaced when the solvent is found to be no longer cleaning properly.) The only cost associated with

solvent purchase is the cost to replace the amount lost during cleaning. The base eliminated 12,000 gallons of cleaning solvent from the waste stream, which is equivalent to 96,000 pounds of hazardous waste. Only the rolls of paper towels or toilet paper have to be disposed of as hazardous waste; two years after installing the filters, Shaw AFB has not yet filled even one 55-gallon drum.

The innovative waste reduction idea and the financial savings resulted in Shaw AFB receiving the Governor's 1995 Pollution Prevention Award in the category Honorable Mention for Excellence in Hazardous Waste Reduction in the large-size business/industrial facility category. The award recognizes the achievements of South Carolina businesses and industries that have exhibited an outstanding commitment to protecting the environment through innovative pollution prevention technologies, environmental benefits, and commitment by management. (Point of Contact: Christine Steagall, 20 CES/CEV, Shaw AFB, DSN 965-5213 or (803) 668-5213.)

Nellis AFB Tests Precision Mix Paint System

Is your installation responsible for painting aircraft?

Do you need to reduce the amount of hazardous waste being generated by this process?

If so, you might want to call the Corrosion Control Section at Nellis AFB, [Nevada,] to hear about the reductions they have achieved since purchasing a Precision Mix Paint System (P-Mix). Using the P-Mix, the shop has:

- Reduced paint waste generation from 104 drums per year to 20;
- Eliminated the time needed for the labor-intensive job of paint mixing;
- Reduced the time needed for cleaning paint waste; and
- Eliminated over-mixing, which has saved 15 kits of paint weekly.

Prior to purchasing the P-Mix, the Corrosion Control Section was mixing paint by hand, which often resulted in excess paint. The P-Mix is an electronic system that was built to be used in hazardous environments. It continuously mixes resin and catalyst to your pre-selected ratio in an integrator, delivering the mixed material on demand. The P-Mix can detect ratio problems and prevents off-ratio coating from being applied. This results in a sensational reduction in rejection rates.

Further, color changes take about 30 seconds, as this is done automatically and in small quantities. Set up time is also reduced because ratio changes are entered electronically. All materials are contained in the system; the electronic control allows color changes and flushing to take place without exposing the operator to hazardous materials. This system can also generate hard copy reports for environmental and product information. Some of the operating parameters reported are flow rate, mix ratio, resin usage, catalyst usage, and solvent usage (by day, time, shift, etc.).

Total annual savings has been estimated at \$112,000 annually. The system will pay for itself in 2 1/2 years. (Point of Contact: Bob Ostrea, Pollution Prevention, Nellis AFB, DSN 682-9722 or (702) 652-9722 or TSgt Tom Layden, Corrosion Control, DSN 682-2589 or (702) 652-2589.)

A Look at Lead-Based Paint

Lead is a metal that is highly toxic if ingested, inhaled, or absorbed through the skin. Most houses and apartments built before 1978 were painted with paint containing lead, including housing and other buildings on some ACC bases. In most cases, lead-based paint that is in good condition is not a hazard; however, chipping, peeling, chalking, or cracking lead-based paint can pose a serious hazard, especially for children.

If you live in base housing, you can call Civil Engineering and find out if your home contains lead-based paint. Most ACC bases have surveyed and sampled base housing units, as well as schools, hospitals, parks, playgrounds, and public buildings, and areas of potential risk have been identified and abatement is underway.

Lead-based paint can be hazardous when it is scraped or chipped and when it becomes airborne as lead-containing dust because the smaller particles are more easily absorbed by the body. Hazardous lead-containing dust can be created from normal abrasion of painted surfaces, such as occurs during the opening and closing of windows. Lead dust is also a problem when exterior paints wash off and accumulate in the soil around the house, which is where children often play. It has been estimated that 1 out of every 11 children in the United States has dangerous levels of lead in the bloodstream.

To decrease exposure to lead paint in your home:

- Keep your children away from flaking and peeling paint. If you live in base housing, notify the base housing office right away if paint starts to peel.
- Wet mop floors and clean window sills and other surfaces regularly to remove dust that may contain lead. Don't use a vacuum cleaner, as this will actually spread the dust around your home.
- Wash children's hands before they eat and wash objects that infants and children put in their mouths.
- Don't sand, scrape, knock down walls, or perform other "do-it-yourself" projects on surfaces unless you have checked with Civil Engineering to see that they are lead free.
- Even though lead-based paint has been banned since the 1970s, some old cans may still be around. Be sure you don't use lead-based paint under any circumstances, and that any excess you may have is disposed of properly. Whenever possible, use water-based paints, which are non-toxic and perform as well as their oil-based (usually lead-containing) predecessors.

Lead in Miniblinds

In response to consumer concern, the Consumer Products Safety Commission (CPSC) released a fact sheet on lead in vinyl window blinds. In summary: imported miniblinds (from China, Taiwan, Mexico, and Indonesia) have been analyzed and test results indicate lead is present in the plastic. (Lead levels as high as 1021 micrograms per square foot have been detected in some miniblinds.) Over time, the plastic deteriorates from sunlight and heat to form lead dust on the blinds. Children then have the potential to ingest the lead after placing their hands on the blinds and then placing their hands in their mouths.

(Continued on middle of page 25)

History of the F-15 Program: A Silver Anniversary First Flight Remembrance

***Captain David R. King, USAF
Captain Donald S. Massey, USAF***

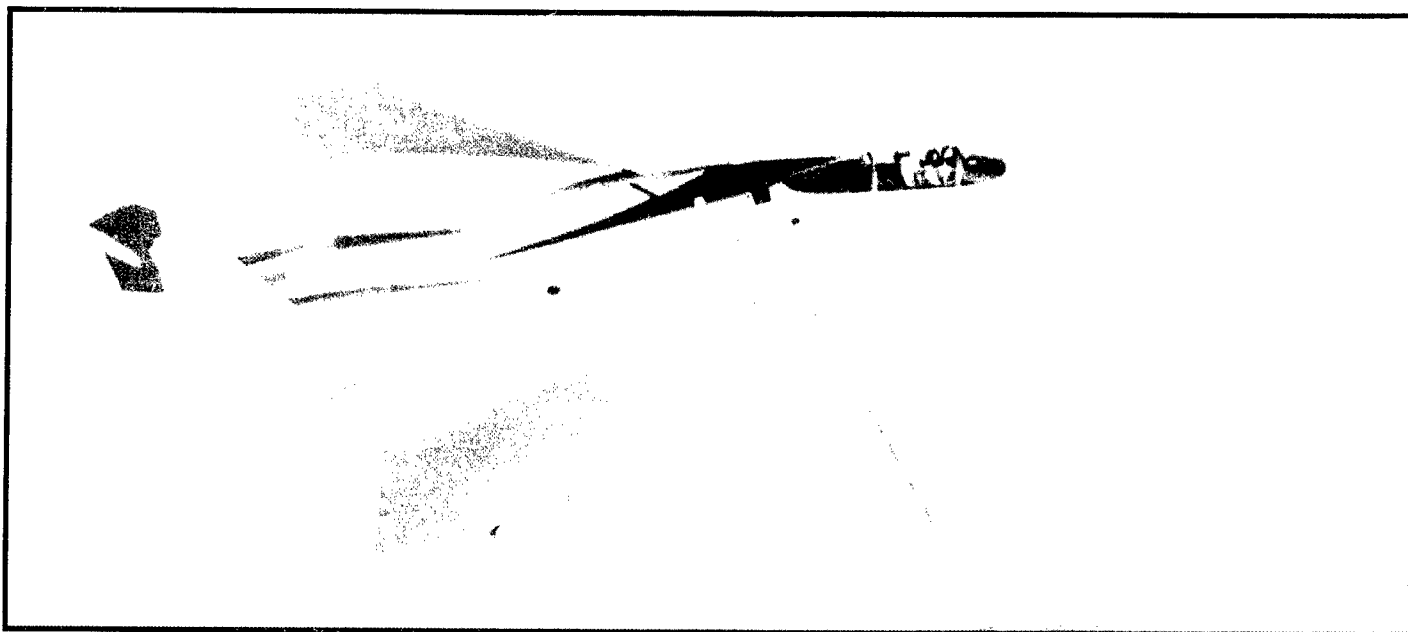
Introduction

In July 1967, the Soviet Union unveiled a new generation of combat aircraft during an air show at Domodedovo civil airport south of Moscow. The MiG-25 Foxbat, featuring two engines, twin vertical stabilizers, and an estimated speed greater than Mach 2, was the most formidable aircraft in this new air armada. (5) The twin-tailed fighter alarmed Air Force planners and highlighted the need for a new fighter designed to fill the air superiority role—a role that had not been fulfilled since development of the F-86 Sabre in the late 1940s. (27:181) General Dynamics and McDonnell Douglas were awarded concept exploration contracts in December 1967 for “FX Air Superiority”—a fighter superior in air combat to any present or projected Soviet fighters. (25) The contracts resulted in an Air Force request for proposal for preliminary designs of the F-15. Fairchild-Republic, McDonnell Douglas, and North American Rockwell won design contracts for the F-15 in December 1968. (14)

In an effort to reduce development time and costs, the Air Force awarded McDonnell Douglas the F-15 contract on 23 December 1969—without a competitive fly-off. At the time, critics argued that an award of this type would result in cost overruns and program delays. (1:18) However, the F-15 program has become

one of the most successful aircraft development and procurement programs in Air Force history. Although mishaps have claimed a number of F-15s, and two F-15Es were lost to ground fire during Operation DESERT STORM, the F-15 has triumphed in 96.5 aerial engagements without loss of a single aircraft. (31) Today, the McDonnell Douglas F-15 remains the Air Force’s primary air-superiority and interdiction platform and will continue to operate in that role until replaced by the F-22 early in the next century.

27 July 1997 marks the silver anniversary of the McDonnell Douglas F-15 Eagle’s first flight. The F-15 has defended the national interests of the United States and its allies for 25 years—from the rolling hills of Europe, to the vast expanses of the Pacific, to the bitter cold of Alaska and the North Atlantic, to the deserts of the Middle East. To celebrate this silver anniversary, we present a historical review of the F-15 program. Specifically, we explore the evolution of the F-15 program, examine the role of the F-15 in technology development, address logistical challenges to the F-15 program, and highlight the combat history of the F-15. We conclude with a look at what the future holds for the F-15 program. We dedicate this article to the Eagle Keepers who have kept the F-15 at the ready, around the clock, for a quarter of a century.



Initial Flight Test of the F-15A Occurred on 27 July 1972. Production Aircraft Would Incorporate Curved Wing Tip Caps and Notches in the Horizontal Stabilizers to Improve Flight Performance.

Three Generations of Eagles

F-15A/B Eagle

The first F-15A rolled out of the McDonnell Douglas St. Louis assembly plant on 26 June 1972. Following a brief ceremony, the contractor dismantled and loaded the aircraft aboard a C-5A for transport to Edwards AFB, California. (4:18) Irving Burrows, the McDonnell Douglas Chief Test Pilot, flew the F-15A on its maiden flight at Edwards AFB on 27 July 1972. (10) Initial flight testing led to a larger speed brake, notched horizontal stabilizers, and curved wing tip caps. (12:628) On 14 November 1974, President Gerald Ford presided over a ceremony at Luke AFB, Arizona, where the Tactical Air Command and the 555th Tactical Fighter Training Squadron took delivery of the first operational F-15A. (32) The 1st Tactical Fighter Wing (TFW), Langley AFB, Virginia, became the first operational combat wing to receive F-15A/Bs (the F-15A is a single-seat model and the F-15B is a two-seat model) and began converting from the F-4 Phantom in January 1976. (33:17) The following year, the 36th TFW, Bitburg AB, Germany, became the first overseas unit to receive the Eagle. (12:629) Ultimately, McDonnell Douglas delivered over 360 F-15A/B aircraft to the US Air Force, with the last deliveries going to fighter interceptor squadrons throughout the Air Force. (3) As the next generation F-15C/D aircraft began entering the Air Force inventory, existing F-15A/B aircraft were sent to Air National Guard (ANG) units or the Aerospace Maintenance and Regeneration Center at Davis-Monthan AFB, Arizona. (3) Today, F-15A/B aircraft are flown by ANG units in Florida, Hawaii, Louisiana, Massachusetts, Missouri, and Oregon. (8:106)

F-15C/D Eagle

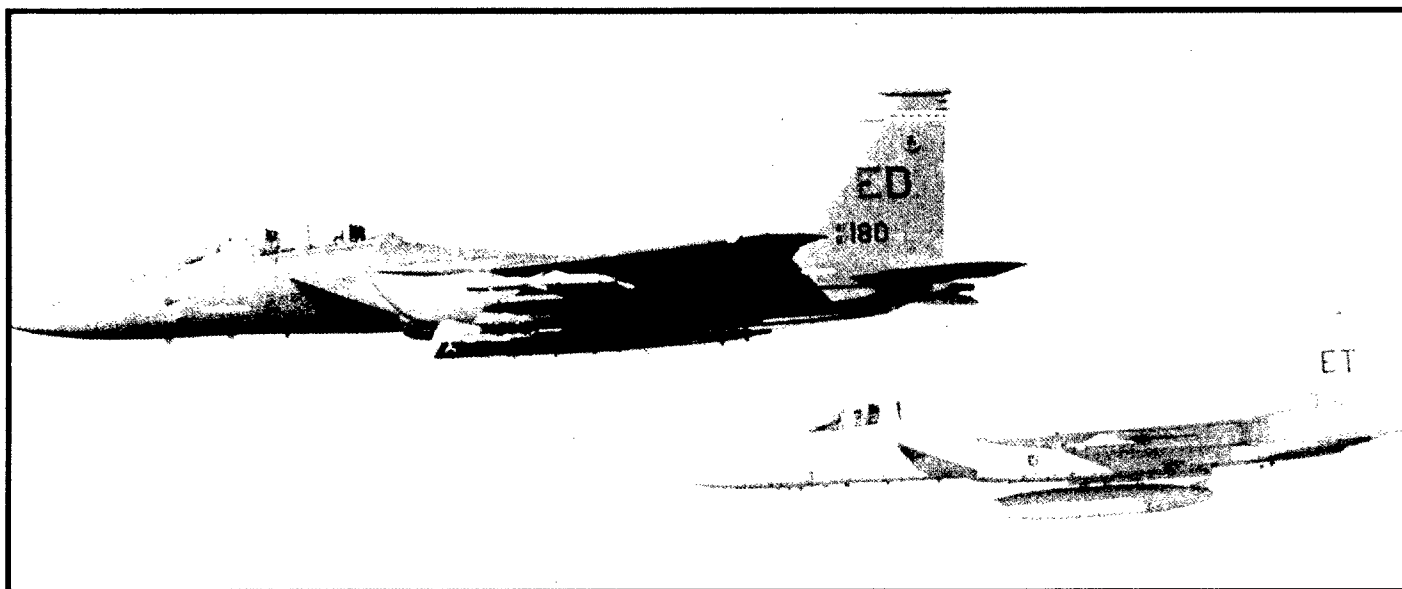
The next version of the Eagle, the F-15C/D, began entering service with the Air Force in June 1979. (8:132) The Air Force ultimately received a total of 408 F-15Cs (single-seat) and 62 F-15Ds (two-seat). (3) Externally, the F-15C/D is nearly identical to the F-15A/B. However, the newer model carries an additional 2,000 pounds of fuel internally and has the ability to carry

conformal fuel tanks. Additional improvements to the F-15C/D aircraft continued under the Multi-Stage Improvement Program (MSIP). MSIP upgrades were first integrated into the F-15C/D production line and later incorporated into earlier F-15s during retrofit at the depot maintenance facility at Robins AFB, Georgia. The MSIP improvements include structural, radar, and electronic warfare upgrades, along with wiring needed to employ the advanced medium range air-to-air missile (AMRAAM). The F-15C/D aircraft with the MSIP upgrade began entering the Air Force inventory in 1985. (8:132-133) The last F-15 aircraft modified for MSIP improvements left Robins AFB on 20 March 1997. F-15C/D aircraft are currently assigned to Eglin AFB, Florida; Elmendorf AFB, Alaska; Kadena AB, Japan; RAF Lakenheath, United Kingdom; Langley AFB, Virginia; Mountain Home AFB, Idaho; Nellis AFB, Nevada; Spangdahlem AB, Germany; and Tyndall AFB, Florida. (8:77,91,93)

F-15E Strike Eagle

Although the F-15 aircraft evolved as a response to an air-superiority threat from the former Soviet Union, its multi-role potential was recognized as early as 1972 by Air Force leaders. (4:18) The need for a multi-role platform emerged in the early 1980s when the Air Force began looking for a replacement for the F-111 under the Dual-Role Fighter (DRF) program. The DRF concept planned for development of an aircraft with the capability to conduct strike missions unescorted by fighters or jamming aircraft. In order to limit the cost of the DRF program, the Air Force considered variants of existing aircraft that met the DRF requirement. The DRF studies led to a fly-off competition between modified F-15 and F-16 aircraft. (21:18)

The F-15E won the ensuing DRF competition in February 1984. (21:18) Full scale development of the day-night, all-weather F-15E began the same year, with the first production aircraft flying on 11 December 1986. (26) Although the F-15E is very similar to the F-15D and retains the full air-to-air capability of earlier models, the aircraft is optimized for air-to-ground missions. The F-15E incorporates a stronger airframe for carrying



An F-15C Shadows an F-15E During Advanced Medium Range Air-to-Air Missile (AMRAAM) Flight Tests.

air-to-ground munitions, uses conformal fuel tanks for additional range, and employs a second crew member to monitor and employ the aircraft's weapons systems. However, the most significant improvements to the F-15E were in the avionics systems. Improvements included: an improved radar for air-to-ground targeting; a two pod system for high speed, all-weather low level flight and targeting called Low Altitude Navigation and Targeting Infrared for Night (LANTIRN); and enhanced cockpit instrumentation. (16:43-47)

The F-15E achieved initial operational capability in October 1989 at Seymour Johnson AFB, North Carolina. (17:652) Operational F-15E aircraft are currently assigned to Eglin AFB, Elmendorf AFB, RAF Lakenheath, Mountain Home AFB, Nellis AFB, and Seymour Johnson AFB. (8:77,91,93) The last F-15E was scheduled to be delivered to the Air Force in June 1994. However, the production lines were kept open when Saudi Arabia and Israel both ordered foreign military sales (FMS) versions of the F-15E. The FMS purchases, combined with 1995 congressional approval for additional United States F-15E aircraft, should keep the F-15E production line in operation until the end of the century. (17:652)

Technology Development and Foreign Military Sales

Streak Eagle

During the winter of 1974-75, the Air Force modified an F-15A for Operation Streak Eagle in an attempt to set world time-to-climb records. To reduce weight, engineers and maintenance personnel removed all non-mission critical systems, including paint. The record attempts were made at Grand Forks AFB, North Dakota, to take advantage of the greater lift provided by the cold, dense air. During the record-breaking attempts, the aircraft carried

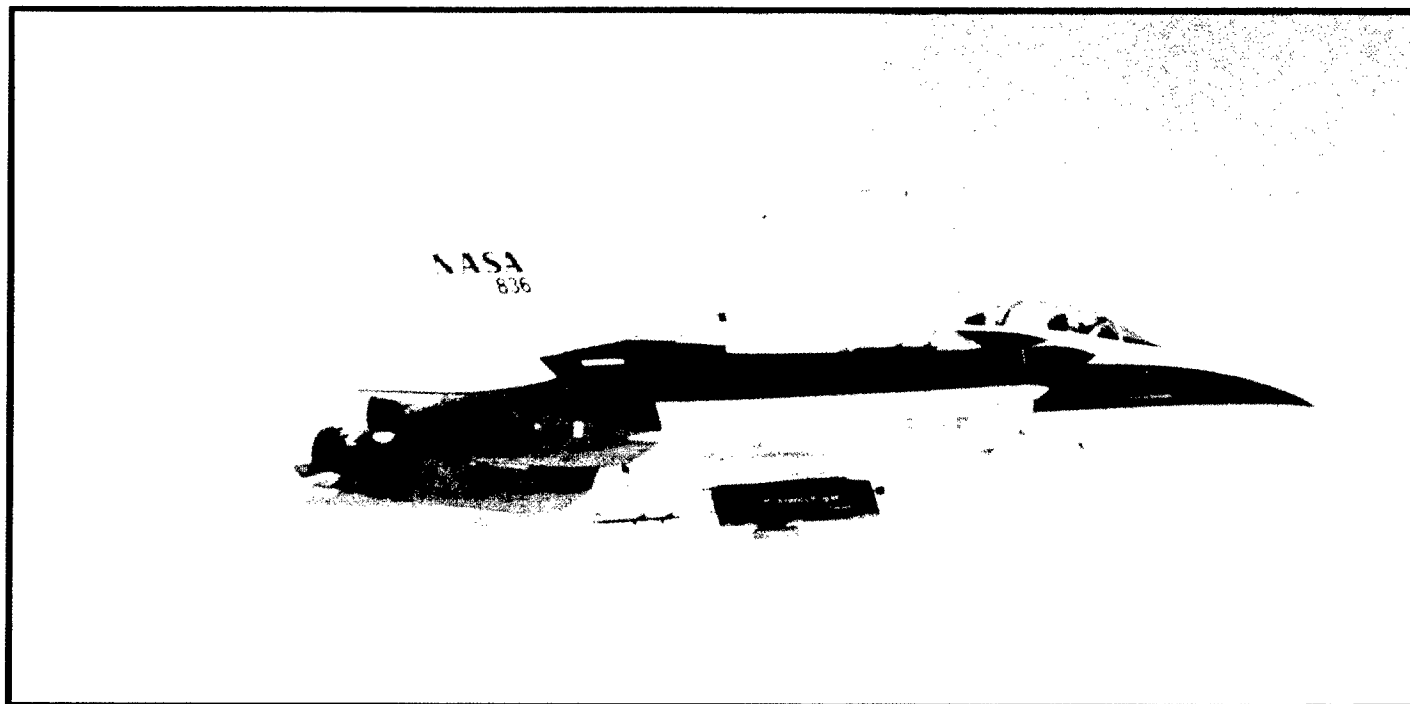
only enough fuel for each specific flight profile. The Streak Eagle ultimately set eight time-to-climb records, shattering records previously held by the McDonnell Douglas F-4 and the MiG-25. (7) The Streak Eagle is currently on display at the Air Force Museum, Wright-Patterson AFB, Ohio.

National Aeronautics and Space Administration (NASA)

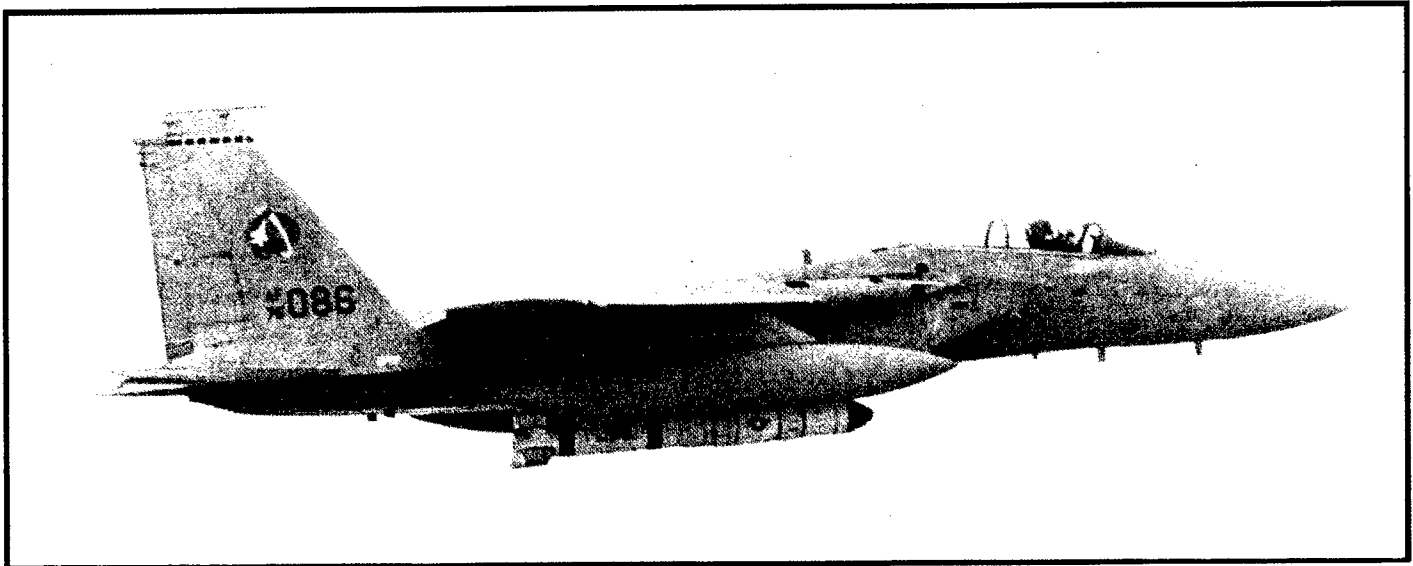
Two F-15As have been assigned to NASA's Dryden Research Center, Edwards AFB, as testbed aircraft since the mid 1970s. These aircraft have been instrumental in developmental testing of advanced aerospace systems being integrated into current and future aircraft. Some of these test programs included: the Self-Repairing and Self-Diagnostic Flight Control Program, the Self-Diagnostic Flight Control System, and the Advanced Digital Engine Control System. (16:71-73) Perhaps the most notable flight experiment involved testing the shuttle's thermal protection tiles. The tiles were mounted on the leading edge of a centerline pylon and subjected to dynamic pressures greater than that experienced by the shuttle during launch. (31)

F-15 Anti-Satellite (ASAT)

The F-15 ASAT program was designed to destroy an orbiting satellite by launching a missile from an F-15 at the upper reaches of the aircraft's flight envelope. The F-15 ASAT missile consisted of a two-stage rocket and a miniature kinetic-energy vehicle. The kinetic-energy vehicle had a liquid helium-cooled infrared seeker to guide the vehicle into a collision with the target satellite. (36:240) An F-15A was extensively modified with a special centerline pylon for carrying the 2,700-pound weapon and a cryogenic tank for carrying liquid helium in the aircraft's ammunition bay. (35) Beginning in the early 1980s, a series of captive and live fire flight tests were conducted to evaluate aircraft and missile compatibility and evaluate overall system performance. (2) The only F-15 ASAT launch against an actual



A National Aeronautics and Space Administration (NASA) F-15A Serves as the Testbed for Space Shuttle Tile Weather Durability Tests. Tiles are Mounted on the Leading Edge of a Modified Centerline Pylon.



The F-15 Anti-Satellite (ASAT) Program Brought a New Dimension to Air-to-Air Combat.

satellite occurred on 13 September 1985 when the test aircraft took off from Vandenberg AFB, California, climbed to 80,000 feet, and launched the 17-foot long, 18-inch diameter missile against the Solwind P78-1 satellite. The F-15 ASAT system performed flawlessly and destroyed the Air Force operated satellite. (9:20) However, the F-15 ASAT program was officially terminated in 1988, after Congress prohibited further tests because they were viewed as a violation of a US-Soviet treaty forbidding the development and testing of anti-satellite weapons. (24:15)

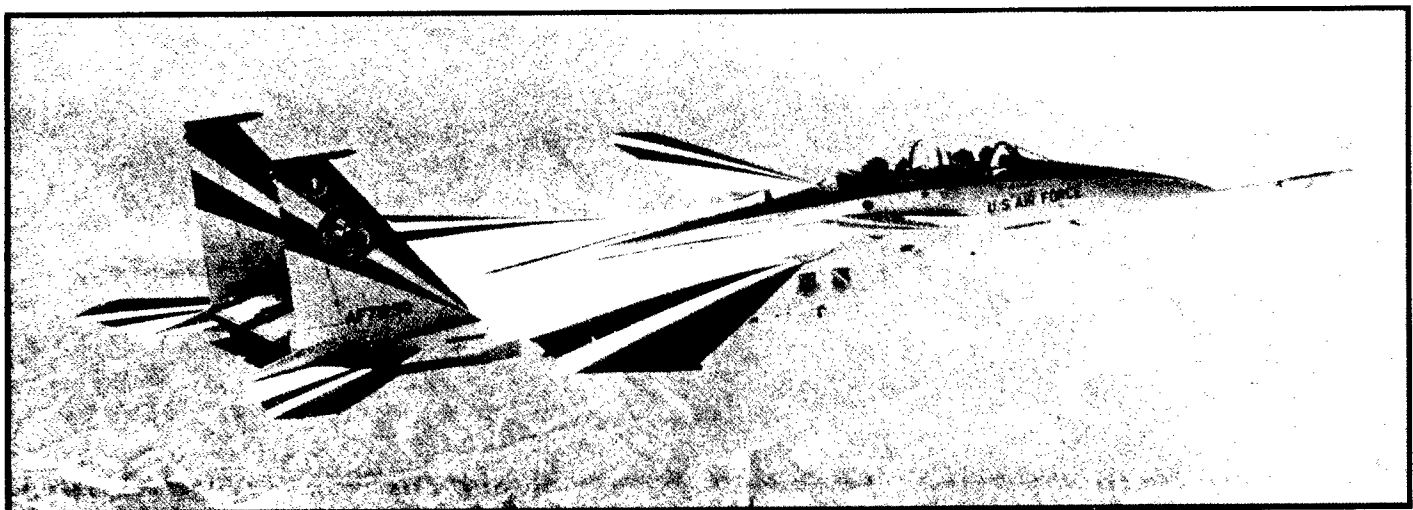
Agile Eagle

In 1984, the Air Force awarded a contract to McDonnell Douglas for an advanced Short Take-Off and Landing (STOL)/Maneuvering Technology Demonstrator (MTD) experimental aircraft. The goal of the program, dubbed Agile Eagle, was to develop an aircraft that could land and take off from battle damaged runways and demonstrate improved maneuverability. An F-15B was modified as the STOL/MTD aircraft for the project. The F-15 STOL/MTD modifications, designed to give the aircraft

the ability to land on wet, 50 x 1,500-foot runways at night or under adverse weather, included: canards, a fly-by-wire integrated flight/propulsion control (IFPC) system, two-dimensional thrust vectoring and reversing engines, and advanced avionics. (18:107,109) The Agile Eagle program ended in August 1991 after meeting all of its flight objectives. (34) Engine technology acquired during the Agile Eagle program was used in development of the F-22's Pratt and Whitney F119-PW-100 vectored thrust engines. The F-15 STOL/MTD aircraft is currently at NASA's Dryden Research Facility and has completed 33 flight tests of a Pratt and Whitney three-dimensional vectored nozzle (vectored thrust in 360 degrees, including pitch and yaw). (6)

Advanced Medium Range Air-to-Air Missile (AMRAAM)

The F-15C was one of four aircraft involved in the development and testing of the Advanced Medium Range Air-to-Air Missile (AMRAAM). The AMRAAM program was placed in jeopardy in late 1989 after four AMRAAMs simultaneously launched from the F-15 test aircraft missed the four target aircraft.

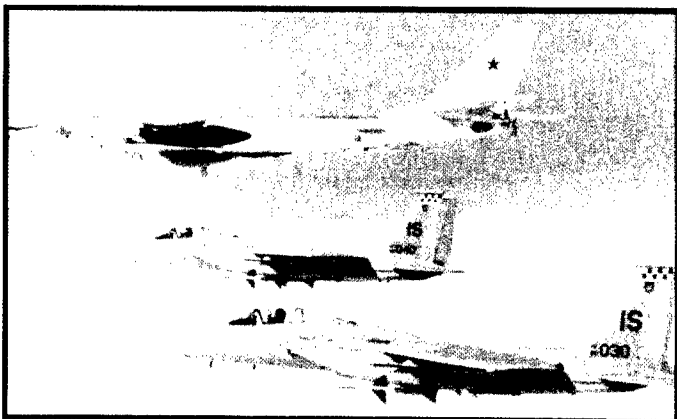


The Agile Eagle Short Take-Off and Landing/Maneuvering Technology Demonstrator Featured Canards and Vectored Thrust Engines.

(23:24) However, the test was successfully completed in May 1990 after a combination of missile and aircraft compatibility problems were corrected. (13) Although none were launched in combat, the F-15 became the first aircraft to carry the AMRAAM into battle, when the missiles were carried on 33rd TFW aircraft towards the end of the Gulf War. (19:7)

Conformal Fuel Tanks

Fuel and Sensor Tactical (FAST) packs, later called conformal fuel tanks (CFTs), were developed to increase the combat capability of the F-15C/D. The CFTs attach to the fuselage along the side of each air intake and permit the carriage of either air-to-air or air-to-ground weapons. CFTs extend the range, sortie duration, and combat capability of the aircraft, while minimizing the limitations imposed by external fuel tanks. F-15C/Ds using CFTs increase their fuel load by 25% and experience 40% less drag when compared to aircraft configured with two wing tanks. Degradation of air-to-air capability is minimal since the CFTs become non-load bearing components of the aircraft structure once empty. (38) Currently, only F-15E aircraft use CFTs. The last F-15C/D unit to fly with CFTs was the 57th Fighter Squadron, Keflavik Naval Air Station, Iceland, where the nearest divert location was over 750 miles away in Lossiemouth, Scotland.



F-15Cs of the 57th Fighter Interceptor Squadron, Keflavik Naval Air Station, Iceland, Intercept a Soviet Bear Bomber Over the Frigid North Atlantic. Conformal Tanks Extended the Range and Sortie Duration of the F-15.

Foreign Military Sales

During the 1970s and 1980s, US aircraft manufacturers experienced fierce competition for military aircraft sales abroad. Aircraft such as the Grumman F-14 Tomcat, the General Dynamics F-16 (now produced by Lockheed Martin), and the McDonnell Douglas F-15 and F-18 vied with one another, and aircraft produced by other countries, for lucrative foreign military contracts. Ultimately, the F-15 found its way into the air forces of Israel, Japan, and Saudi Arabia. In 1976, Israel became the first foreign country to take delivery of the F-15, and since that time, the Israel Defense Force has confirmed 59.5 kills with the F-15. (12:630; 31) Israel currently maintains 44 F-15A/B and 28 F-15C/D aircraft and will begin taking delivery of 21 export versions of the F-15E in 1997. (28) In the late 1970s, Japan became the second foreign country to receive the F-15. Following

an initial delivery of McDonnell Douglas built aircraft, Mitsubishi Company assumed the role of primary contractor for production of Japanese Air Self Defense Force F-15J/DJ aircraft. (16:51-52) Including scheduled deliveries, Japan currently maintains an inventory of 166 F-15J (single-seat) and 43 F-15DJ (two-seat) aircraft. (29) Saudi Arabia began purchasing F-15C/D aircraft for the Royal Saudi Air Force (RSAF) in the early 1980s and has programmed purchases of an export version of the F-15E through 1998. (30) The RSAF downed two Iraqi Mirage F-1s with the F-15 during Operation DESERT STORM. (31)

Logistics Support

The F-15 program has experienced numerous logistical challenges during the last 25 years. Initially, Air Force planners concentrated on procurement of aircraft as opposed to procurement of spares, and early F-15 units suffered from spares shortages. (11,20:24) The shortages were exacerbated as more aircraft entered service. While initial shortfalls in spares procurement have been largely resolved, many systems on the aircraft continue to experience parts shortages. Additionally, poor reliability plagued the F-15A/B's new Pratt and Whitney F100-PW-100 turbofan engines. (11) The reliability problems associated with this new generation, modular engine were largely overcome through technical modifications and improvements to materials, maintenance, and operating procedures. Over the years, engine upgrades have improved the performance and supportability of the F-15's engines.

Current logistics challenges for the F-15A/B/C/D stem from subsystem incompatibility between older and newer configurations, and accumulated wear and tear on flight control surfaces. Logistics support for older avionics systems like the APG-63 radar requires innovative parts management and unique software support to incorporate improvements to the older systems. Additionally, cathode ray tubes (CRTs) used in the F-15 cockpit are increasingly difficult to support as the aerospace industry moves to flat panel displays, and fewer contractors are available to build and repair CRTs. Finally, aging flight control surfaces require ever increasing attention due to limited funding and difficulties associated with repair of older flight control components. (3)

Today, logistic support problems for the F-15E center around CRTs. The monthly demand rates for CRTs often exceeds the capacity of available contractor support. In the case of the multi-purpose color display (MPCD), the addition of another contractor certified for CRT production should resolve current shortfalls. However, for many other systems using CRTs, an upgrade to the system itself may prove to be the only real solution. (37)

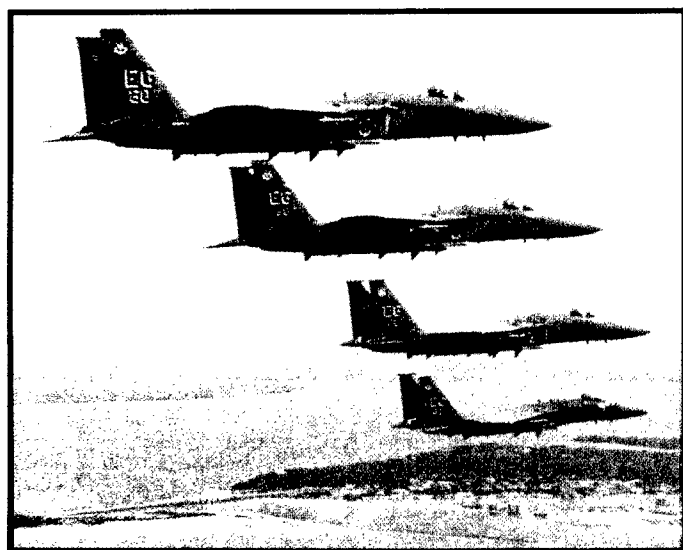
Combat

Ironically, the F-15's first combat engagement was not flown by the US Air Force, but by the Israeli Defense Force (IDF). On 27 June 1979, during an escort mission for aircraft striking terrorist bases in southern Lebanon, a flight of Syrian MiG-21s attempted to intercept the attacking Israeli force. Six Israeli F-15s engaged and destroyed five MiG-21s, enabling the IDF

aircraft to complete their mission and return safely to base. (15:166) The first victory against a MiG-25, the threat the F-15 was designed to counter, was also claimed by the IDF.

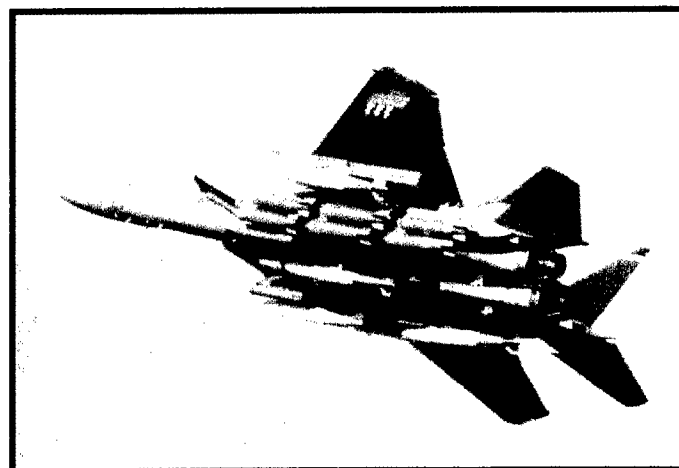
The first aerial victories for US Air Force F-15s would not be in the skies over Europe, as had been anticipated during the height of the Cold War, but over the deserts of the Middle East. At the beginning of August 1990, Iraqi forces invaded Kuwait and began a massive buildup along Saudi Arabia's northern border. On 6 August 1990, following a series of meetings with Saudi and Kuwaiti leaders, the US responded to the Iraqi aggression with Operation DESERT SHIELD. Within 36 hours of deployment notification, F-15C/D aircraft from the 1st TFW, Langley AFB, were on the ground in Saudi Arabia. (22:32) Over the next five months, other F-15C/D/E units from the 4th TFW, Seymour Johnson AFB; the 33rd TFW, Eglin AFB; the 36th TFW, Bitburg AB; and the 32nd TFG, Soesterberg AB, The Netherlands, would deploy to Saudi Arabia and Turkey. (19:7) Throughout the buildup of coalition forces, F-15C/D/E aircraft flew combat air patrols and training missions with the air forces of other coalition nations. On the morning of 17 January 1991, coalition forces took the offensive as Operation DESERT SHIELD gave way to Operation DESERT STORM.

The majority of coalition air-to-air engagements during the Gulf War were fought by US Air Force F-15Cs against Iraqi aircraft attempting to flee to Iran. In total, F-15Cs accounted for 36 of the 39 enemy aircraft destroyed by the Air Force during the war. (8:133) The fact that the 36 kills were achieved without a single combat loss is testament to the capabilities of the weapons system and the abilities of our pilots and logistics personnel. Twenty-five of the F-15C kills were beyond visual range using the AIM-7 Sparrow missile, while ten additional kills were made with the AIM-9 Sidewinder missile. Perhaps the most unusual F-15 victory of the war occurred when an F-15C pilot maneuvered his aircraft in such a manner that his MiG-29 opponent was forced into the ground. (19:6-7)



F-15Cs, Including Those of the 58th Tactical Fighter Squadron, Eglin AFB, Flew Over 5,900 Sorties and Dominated the Skies Over Iraq.

In early August 1990, F-15Es of the 336th Tactical Fighter Squadron (TFS), 4th TFW, Seymour Johnson AFB, deployed to the Persian Gulf region. Although these aircraft lacked the targeting pod for the LANTIRN system, the Strike Eagles served as a viable deterrent to further escalation on the part of Iraq. (19:8) In December 1990, F-15Es of the 336th TFS joined those of the 335th TFS (its sister squadron from Seymour Johnson AFB) at Al Kharj, Saudi Arabia. (16:68) While at Al Kharj, both squadrons received a total of 24 LANTIRN targeting pods, which were successfully employed throughout the war. Perhaps the most publicized of the 2,200 sorties flown by the F-15Es during the war were "Scud-busting" missions. During these missions, Strike Eagles joined other coalition aircraft in searching for and attacking Iraqi Scud missile launchers targeted at Israel and Saudi Arabia. (19:8)

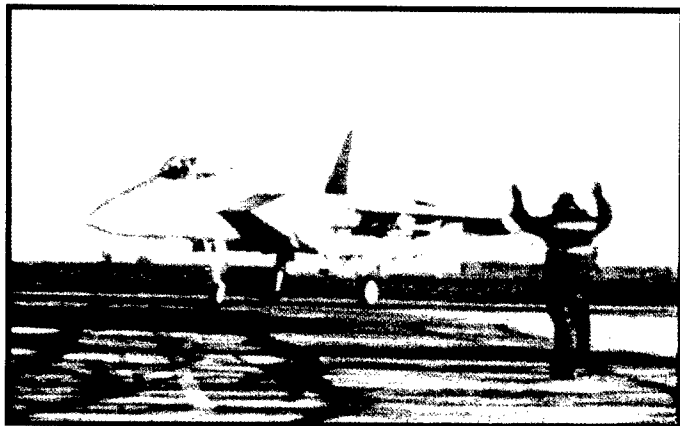


An F-15E Undergoing Weapons Flight Tests Illustrates the Level of Firepower Brought to Operation DESERT STORM by the 4th TFW, Seymour Johnson AFB.

A Look Ahead

Today, US Air Force F-15s continue to enforce "no-fly" zone restrictions on Iraqi fixed-wing aircraft imposed under the terms of the United Nations cease-fire agreement and are an integral part of ongoing Air Expeditionary Force deployments. Although the F-22 is scheduled to begin replacing F-15 C/D aircraft as early as 2005, the F-15C/D fleet should remain in service well beyond that date. Additionally, because a replacement is not currently on the books, one can expect the F-15E Strike Eagle to remain in service well into the next century. As we move into the 21st century, the F-15 weapon system will remain the US Air Force's primary air superiority and interdiction platform.

The F-15 program has a proud history highlighted by combat success, numerous time-to-climb records, and innovation for aerospace technology. The accomplishments of the F-15 program can be attributed to the myriad of people supporting the program over the last 25 years. As the F-15 launches into the next century, the continued success of this premier air superiority and interdiction aircraft is in the safe, capable hands of the Eagle Keepers.



As the Mission Draws to an End, This F-15C Returns Home to the Capable Hands of the Eagle Keeper.

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Captain King is an acquisition officer and has worked with the F-15 program for six years. He is currently the Chief of the F-15 Avionics Section, F-15 System Program Office (SPO), Warner Robins Air Logistics Center, Robins AFB, Georgia. He was previously assigned to the F-15 SPO, Wright-Patterson AFB, Ohio, as a program manager for weapons integration and as an F-15E flight test manager.

Captain Massey is presently a project manager in the Maintenance and Munitions Division at the Air Force Logistics Management Agency, Maxwell AFB, Gunter Annex, Alabama. He was previously assigned to the 57th Fighter Squadron, Keflavik Naval Air Station, Iceland, where he was responsible for F-15C/D flight line maintenance.

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Air Force Logistics Management Agency Fiscal Year 1997 (FY97) Program

Below are our in-work projects for FY97. If you are interested in any of these projects, please contact the project officer. Commercial access for all phones is (334) 416-xxxx.

Contracting

Market Research/Analysis Guide, LC9622200

Objective: Develop a market research/analysis guide for contracting and its functional experts which will address: an overview of the market research/analysis process; practical application of market research/analysis; roles of the participants; research and analysis techniques; and an example of a market analysis to include techniques, definitions, and sources for assistance.

Capt Thomas J. Snyder, AFLMA/LGC, DSN 596-4085

Acquisition Streamlining/Reform in Operational Contracting, LC9622201

Objective: Develop a road show training approach (content and delivery method), which links acquisition streamlining and reform initiatives to the Deputy Assistant Secretary for Contracting's (SAF/AQC's) main goals and objectives. The road show must emphasize policy, processes, and tools which can be applied in providing best value, timely support to customers. In addition, the road show must concentrate on practical application rather than concepts.

SMSgt Jose R. Medina, AFLMA/LGC, DSN 596-4085

Analysis of Effects of International Merchants Purchase Authorization Card (IMPAC) Usage, LC9622202

Objective: Analyze the economies of using IMPAC to give SAF/AQCO an estimated cost per transaction that can be used to determine approximate cost savings and/or avoidance per transaction and an Air Force average cost or savings. The analysis will consider activities that incur costs to support the program which include: the user, cardholder and approving official, supply, comptroller, and contracting levels. The next step will be to determine the average savings and/or avoidance or costs which apply strictly to operations performed in contracting offices when IMPAC is used. Additional areas for review and recommendations include: IMPAC training requirements; management and oversight; cardholder duties in purchasing, documenting, and reconciling actions; reconciliation; automation; joint resolution issues; and potential for future savings considering open market purchases exceeding \$2,500.

Maj John C. Perry, AFLMA/LGC, DSN 596-4085

Maintenance and Munitions

Weapons Load Crew Management Program Update, LM9611300

Objective: Redesign the program from storing data on flat files to a database structure using Microsoft Access and modify it to operate in a windows environment.

CMSgt Allan C. Richardson, AFLMA/LGM, DSN 596-3602

Review of Combat Ammunition System (CAS) Classified Data Handling, LM9522000

Objective: Determine what CAS data is classified. Document whether or not current system is multilevel secure and whether or not alternatives are cheaper in the short term.

Capt Stella T. Smith, AFLMA/LGM, DSN 596-3778

Quality Maintenance Metrics Data Collection and Analysis, LM9607800

Objectives: (1) Develop an automated process to collect and analyze major command quality maintenance data at Air Force level. (2) Develop products for standardized reports and analysis.

Maj Dorothy J. Tribble, AFLMA/LGM, DSN 596-4581

Advanced Traceability and Control for Air Force (ATAC-AF)/Reliability and Maintainability Information System (REMIS) Data Evaluation, LM9611400

Objective: Identify the causes of ATAC-AF/REMIS error rates and provide options to improve ATAC-AF/REMIS data accuracy.

Capt Bradley D. Allen, AFLMA/LGM, DSN 596-4484

Proof of Concept Re-Engineered Base-Level Repair Cycle, LM9617100

Objective: Test the base-level repair cycle redesign effort for a reduction in processing times and verify process redundancies.

Capt Glenn R. Barney, AFLMA/LGM, DSN 596-4165

Enhancing F100-PW-220 Maintainability and Supportability, LM9618400

Objectives: (1) Identify factors, policies, and procedures impacting the F100-PW-220 maintainability and supportability process. (2) Map the end-to-end F100-PW-220 maintainability and supportability process. (3) Provide recommendations necessary to streamline the F100-PW-220 maintainability and supportability process.

Capt Donald S. Massey, AFLMA/LGM, DSN 596-5676

Bad Actor Program, LM9622500

Objective: Design a workable bad actor program for the Air Force to include: a clear definition of a bad actor; the tools and data elements required by a normative bad actor program; a brief description of existing bad actor programs; recommendations to improve the existing programs; and specific rules and criteria for F-16 and F-15 two-level maintenance (2LM) and three-level maintenance (3LM) avionics parts.

SMSGt William C. Atherton, AFLMA/LGM, DSN 596-3885

Supply

Analysis of Mission Capability/Awaiting Parts (MICAP/ AWP) Reporting, Collection, and Information Systems, LS9400170

Objectives: (1) Determine Weapon System Management Information System/Readiness Assessment Module (WSMIS/ RAM) end-user information requirements. (2) Identify data required to provide information needed by WSMIS/RAM end users and the most effective and accurate method of retrieving required data. (3) Analyze, document, and recommend improvements to existing WSMIS/RAM data transmission processes or, if necessary, outline a redesigned methodology for collecting and reporting required information.

Capt Edward E. Tatge, AFLMA/LGS, DSN 596-4464

System Support Division (SSD) and General Support Division (GSD) Credit Policy Analysis, LS9501900

Objectives: (1) Determine the financial impact on customer Operations and Maintenance (O&M) funds and the SSD stock fund if current SSD credit policy replicated GSD credit policy for field-reparable and expendable items. (2) Evaluate the current GSD credit policy and determine how much of the assets become excess to the base. (3) Determine the impact of changing the credit policy to only grant credit up to the approved retention policies in effect for expendable and field-reparable items.

Capt James A. Neice, AFLMA/LGS, DSN 596-4165

Lean Logistics Retrograde Shipment Policy, LS9508010

Objectives: (1) Define current policies and procedures for retrograde priority shipment. (2) Examine feasibility of using asset position to determine retrograde shipment policy. (3) If feasible, assess the benefits of revising shipment policy in terms of spares requirements, shipment costs, and data system requirements.

Capt Bradley E. Anderson, AFLMA/LGS, DSN 596-5671

Analysis of the Supply Requisitioning System and its Impact on Lean Logistics Implementation, Part II, Systems and Procedures, LS9601800

Objectives: (1) Identify the cause(s) of base and depot requisition database mismatches. (2) Determine the effectiveness and Lean Logistics applicability of current requisition procedures. (3) Recommend short- and long-term corrective actions necessary to improve our requisitioning systems and procedures to facilitate conversion to Lean Logistics.

Capt Richard G. Nelson, AFLMA/LGS, DSN 596-4165

General Support Division (GSD) Lean Logistics Pipeline Reduction, LS9605310

Objectives: (1) Determine current Defense Logistics Agency order and ship time (O&ST) for standard base supply system (SBSS) accounts and the retail accounts at the Air Logistics Centers. (2) Analyze other methods for computing O&ST and determine the impact on GSD budget. (3) Evaluate methods for implementing reduced O&ST into level-setting methods. (4) Evaluate the impact of proposed credit return policies on the GSD budget.

Capt Richard G. Nelson, AFLMA/LGS, DSN 596-4165

Analysis of Retail-Wholesale Asset Position, Usage, and Repair Data Accuracy, LS9607310

Objectives: (1) Determine asset position, usage, and repair data required by wholesale information users. (2) Baseline current retail-wholesale data accuracy. (3) Analyze, document, and recommend improvements to existing asset position, usage, and repair data reporting processes to maximize efficiency and minimize redundant reporting. (4) Recommend methods for field units to correct erroneous wholesale data. (5) Recommend methods to collect, analyze, and report retail-wholesale data accuracy on a recurring basis to assess improvements or degradations in accuracy over time.

Capt Richard G. Nelson, AFLMA/LGS, DSN 596-4165

Forward Looking Readiness Based Leveling (RBL), LS9622000

Objectives: (1) Outline the concept of forward looking RBL. (2) Provide operational procedures for setting levels through RBL for permanent mission changes and contingency deployments. (3) Document the implementation strategy.

Capt Harry A. Berry, AFLMA/LGS, DSN 596-4165

Analysis of Warranty Parts Management, LS9630500

Objectives: (1) Examine current Air Force and Department of Defense warranty policy. (2) Examine the Quality Deficiency Reporting process for centrally managed items. (3) Recommend improvements to the warranty management process.

Mr Jay P. Mead, AFLMA/LGS, DSN 596-4464

Transportation

Deployment Management System (DeMS), LT9503220

Objective: Provide users with an easy-to-use microcomputer application that communicates over a local area network (LAN) to automate the unit-level deployment process.

Capt Richard R. Coons, AFLMA/LGT, DSN 596-3886

Automated Manifesting System (AMS) Analysis, LT9525600

Objectives: (1) Based on prototype evaluation, assess potential performance improvements to the inbound receipting process. (2) Determine implementation costs. (3) Determine potential cost benefits of AMS application to other locations.

Capt Richard R. Coons, AFLMA/LGT, DSN 596-3886

(Continued on middle of page 41)

Air Force Materiel Command (AFMC) Studies and Analyses Program

The AFMC Studies and Analyses Office (AFMC SAO), a field operating agency under the AFMC Director of Plans (HQ AFMC/XP), conducts and sponsors studies and research of significant materiel issues. Our goal is to provide analytic solutions for improved business practices. We focus our efforts on the development and enhancement of mathematical models which can relate materiel resource decisions to resultant impacts on weapon system availability so AFMC can prioritize and justify its investments in resources. We work closely with our customers as we design and perform studies to ensure we have a healthy balance between the rigorous application of operations research techniques and practical solutions that can be implemented.

The SAO senior staff consists of:

Mr Victor J. Presutti, Jr., Chief, DSN 787-3201

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(Commercial access for all phones is (937) 257-xxxx)

We invite you to visit our SAO Web Site at: <http://www.wpafb.af.mil/organizations/HQ-AFMC/XP/sao>.

Current and Recent Efforts

Retail and Wholesale Stockage Levels for the Air Force

We continued to provide technical support during the testing and implementation of readiness based leveling (RBL). RBL integrates retail (base) and wholesale (depot) environments while it determines the best base stockage levels and depot working levels to achieve the lowest, worldwide, expected base backorders. RBL postures the Air Force for achieving the highest aircraft availability based upon the computed worldwide asset requirement. Two key efforts we accomplished in 1996 were:

(1) We ran the RBL model in-house in support of the PACER LEAN workload in special sites chosen for testing Lean Logistics initiatives. This proved valuable as a prototype for the production system implementation. We were able to analyze data for anomalies and reformat output for easy use in the field. Throughout this process, we discovered and rectified numerous data problems adversely impacting RBL's performance. We made several model improvements, developed model logic to meet the needs of the communications-electronics community, and developed logic to properly recognize the forward depot operation known as the Support Center Pacific (SCP).

(2) We modified our in-house RBL model into a production version to implement in the Readiness Based Leveling System (D035E). We worked with the RBL review team (AFMC Director of Logistics, (HQ AFMC/LG), Materiel Systems Group (MSG), Standard Systems Group (SSG), Air Force Logistics Management Agency (AFLMA), major commands (MAJCOMs), and Air Logistics Centers (ALCs)) in a field test with four base sites to verify operation and correct data or model issues. Our analysis results were key to the Air Force Supply Executive Board (AFSEB) "go-no go" final implementation decision. (Analysts: Bob McCormick, Capt Todd May, DSN 787-6920)

Reparable Stock Division (RSD) Banding for Effectiveness as Inputs to Unit Cost Targets (UCTs)

In light of ALCs' ability to "flex" money between weapon systems and among RSD buy, RSD repair, and System Support Division (SSD) requirements, we created a new methodology to allocate obligation authority (OA). It is based on the exponential banding process we developed in 1993 which prioritizes weapon systems by assigning them "bands." Today, this method utilizes assets on-hand when allocating OA for RSD buy and includes all requirements. Previous approaches for banding did not include nondemand based requirements (for example, additives). This was because of the perception that these requirements had little impact on aircraft availability. We allocated limited RSD buy and repair funding by delivering ALC and weapon system breakouts using this exponential banding process. These breakouts are used by Air Staff as inputs to the Funding/Availability Multi-Method Allocator for Spares (FAMMAS) model, which estimates the impact on weapon system availability, and as inputs into UCTs. UCTs, new for Fiscal Year 1997 (FY97), have brought uncertainty throughout the command as to their implementation, manageability, and effects. SAO is aggressively pursuing projects to help bring clarity and understanding in applying and tracking UCTs, both at the headquarters level and in the field. (Analysts: William Morgan, 1 Lt Bryan Richardson, Thomas Stafford, Capt Keith Poore, DSN 787-6920)

Weapon System Reporting (WSR)

We were asked to be a member of the AFMC Director of Requirements (HQ AFMC/DR) Integrated Product Team (IPT) to help explore "forecasting potential" for single managers using weapon system reporting information. This was a result of a tasking from an AFMC Commander (HQ AFMC/CC) briefing at CORONA Fall 95 about an excessive weapon system reporting burden on single managers. We designed an electronic survey and installed it on the Single Managers' Issues home page for more than 160 weapon and non-weapon related organizations involved with the reporting process. Although no new requirements were borne out of the survey, several issues were raised and directed to the appropriate offices for resolution. We also addressed a concern voiced by the single managers that they had little information on models available that may be useful to their forecasting needs. We developed a product that relates available models to their applications to help single managers and others take better advantage of the forecast and modeling resources currently available Air Force and DoD-wide. The product has three parts: a table of models that relate resources to operational effectiveness (includes name, how it may currently be utilized by current Air Force systems, offices of primary responsibility (OPRs), model description, inputs, and outputs), a bibliography of similarly-related models, and a table of organizations involved in model production and/or research (includes name, organization mission and products, and how to contact them). (Analysts: Capt Todd May, Michael Niklas, DSN 787-6920)

Initial Sparing

The Air Force applies readiness based sparing (RBS) when calculating recoverable item spares requirements for peace and war, but in the past, RBS has not been applied to initial support for new systems or Foreign Military Sales (FMS). In support of several distinct sponsors, we developed a PC-based spares management system consisting of a Foxpro database linked to the RBS model the Air Force uses to compute war spares. We have been and will continue assisting our sponsors in implementing this RBS system. The F-22 System Program Office is using the system to compute initial peace and war spares. The requirements re-engineering team, known as the Supply Support IPT that is revising the Air Force provisioning process, is applying the system in their revised process prototype. A FMS office in San Antonio is working to implement the system within the International Weapon Item Projection System (IWIPS). We also delivered the RBS system to our foreign military customers, installed it, and conducted training. The Argentine Air Force and the Colombian Air Force are using the system to calculate a more cost-effective spares mix to improve C-130 support and OV-10 support, respectively. (Analysts: Karen Klinger, Mike Niklas, DSN 787-6920).

Weapon System Capability Assessment

We have an ongoing responsibility to improve the quality and usefulness of the Weapon System Management Information System (WSMIS) by designing enhancements and solving technical problems. Major changes in airlift modeling took place this year, and we were asked to evaluate the effect on wartime spares requirements and capability assessments. By applying Aircraft Sustainability Model (ASM), Dyna-METRIC, and other analytical software, we were able to identify the causes of various technical and modeling problems. Besides troubleshooting, we were heavily involved in the WSMIS modernization effort. The foundation of the modernization effort will be a new version of the ASM. We have been testing and designing improvements for the new ASM so it can replace the other WSMIS models for both requirements computations and capability assessments. In addition to our WSMIS support, we completed the following assessment efforts:

(1) We were asked to help determine AFMC's capability to support Air Mobility Command (AMC) aircraft (C-5, C-141, C-17, and KC-135) through a two major regional conflicts (2MRC) scenario. Specifically, can AFMC depots keep up with the wartime repair workload so airlifters will have the parts they need to accomplish planned missions for six months of war? Based on this study, HQ AFMC told HQ AMC "we are glad to report to you that the outcome of this assessment is that we are confident of AFMC's ability to support AMC throughout the 2MRC scenario."

(2) The Air Staff requested our assistance for their input to a National Logistics Study. It was requested by the Chairman of the Joint Chiefs of Staff to assess the nation's capability to support the 2MRC scenario. The Air Staff asked for our help to determine which weapon systems are likely to have supportability problems in war. We provided capability assessment summaries for all war-tasked aircraft and researched critical items.

(3) In August 96, AFMC sponsored a Logistics Enhanced Awareness Development (LEAD) Wargame for the 8th Air Force Commander. The game's objective was to examine the logistics capabilities and constraints involved with 8th Air Force responding to a lesser regional conflict (LRC) starting 30 days after the beginning of a major regional conflict (MRC). We were asked to model the MRC and estimate the spares quantities that would be available to support the 8th Air Force during a follow-on LRC. Our feedback was that the information was key to increasing the logistics realism in 8th Air Force's Blue Flag Exercise. (Analyst: Mike Niklas, DSN 787-6920)

Cost-Benefit Analysis for the Contract Repair Enhancement Program

The Contract Repair Enhancement Program (CREP) is developing processes to improve contract repair responsiveness. Depot personnel have the responsibility of evaluating the cost-benefit ratios associated with asking contractors to shorten their repair cycle times. We provided a set of rules for filtering candidate items and developed a cost-benefit analysis spreadsheet which provides an objective evaluation of proposed CREP improvements. For a specified support target, the cost of several combinations of "buy" and "repair" are compared. The least cost alternative is then identified. (Analyst: Mike Niklas, DSN 787-6920)

DRIVE/EXPRESS Implementation Support

We have continued to support the implementation of the AFMC Distribution and Repair in Variable Environments (DRIVE) production system. This has really translated in the past year into supporting the implementation of the Execution and Prioritization of Repair Support System (EXPRESS), a system that was fielded at all ALCs this year to support the repair and distribution of items associated with the various repair shops designated as PACER LEAN shops. The PACER LEAN shops are being used to test the management initiatives presented by the AFMC Commander in his Senior Leader Materiel Course (SLMC). The goal of the total DRIVE/EXPRESS system is to closely link recoverable item depot repair and distribution actions to operational customers' needs. EXPRESS includes the original DRIVE prioritization capability, the DRIVE Distribution Module (DDM), some of the Oklahoma City Air Logistics Center (OC-ALC) developed Automated Induction System (AIS) logic, and a supportability constraint identification module. This past year we completed the implementation of a model change that allows DRIVE/EXPRESS to include non-aircraft items as well as aircraft items. We provided a great deal of systems analysis support to guide the software developers in a number of areas; for example, how to include at least three more levels of indenture of items below the shop replaceable unit (SRU) level. We completed a study that resolved a vigorous debate on what better represents the true customer need at our Air Force bases—requisitioning objective (RO) holes at the base or backorders at the depot. As a result of our working closely with the Contract Repair Enhancement Program (CREP) team which was developing methods to manage contract repair workloads, the team has agreed to adapt their process to use EXPRESS to prioritize the repair and distribution of contract repair items. (Analysts: Bob McCormick, Barb Wieland, DSN 787-6920).

We completed the development of a program which uses data from the DRIVE model and converts it into a format which can be used by Dyna-METRIC to assess capability. By integrating a peacetime and wartime assessment capability into DRIVE, we can estimate the aircraft availability that results from DRIVE's actions. DRIVE's objective function is to maximize the probability of achieving stated peacetime and wartime availability goals while other models used by the Air Force relate the expected aircraft availability achieved to the dollars expended or to the specific spares available. These other models include the Aircraft Availability Model used for peacetime spares requirements computation and capability assessment, the Aircraft Sustainability Model for wartime spares requirements computation, and the Dyna-METRIC model used for wartime capability assessment in the Weapon System Management Information System (WSMIS) and for peacetime capability assessment in special studies. This statement of availability should be more useful to managers than a statement of the probability of achieving availability goals. The conversion program supports peacetime, wartime, and peace followed by war scenarios using data from DRIVE's Part and Scenario files or directly from the desktop DRIVE database. We will focus our future efforts on incorporating it into the EXPRESS system to integrate a capability assessment feature with the EXPRESS repair and distribution prioritization process. (Analysts: Capt Keith Poore, Barb Wieland, Bob McCormick, DSN 787-6920)

In 1997 we plan to continue to devote a major portion of our effort towards implementing new methods for improving the management of materiel spares. This will include methods to determine requirements, allocate resources, execute support actions, and assess impact. Some specific areas on which we will focus are:

- Support the implementation of the RBL system and follow up with additional enhancements.
- Develop decision tools to help manage unit cost targets.
- Enhance the FAMMAS model to assist with repair versus buy decisions.
- Explore the application of EXPRESS for repair planning and funding allocation or develop alternative methods. Develop solutions for multiple sources of repair.
- Enhance the tool to determine when it is economical to increase contract repair responsiveness.
- Support the Air Force implementation of a readiness based sparing system to compute initial peace and war spares.
- Deliver a readiness based sparing model to the Supply Support IPT charged with developing a new initial requirements determination process for new weapon systems.
- Incorporate into WSMIS our procedure for assessing peacetime and wartime capability based on prioritized depot repair and distribution.



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Identifying Situational Constraints in Logistics

*Captain Timothy J. Pettit
Major Joseph T. Dougherty*

Introduction

One of the most important ways logistics managers contribute to organizational effectiveness is by solving process-related problems. Determining how to allocate scarce resources to obtain maximum benefits for the organization is not a simple task. The sheer number of factors affecting logistics systems makes their trouble-shooting task difficult. Rather than "fighting fires" or "greasing the squeaky wheel," a more thorough analysis may provide better insight into the factors influencing the success of the organization. These performance factors, which either inhibit or promote accomplishment, have been labeled situational constraints. Examples include: amount of personnel, availability of tools and supplies, enough time to complete the task, and sufficient funds to purchase equipment and parts.

Proponents of Total Quality Management (TQM) stress the need for workers who are familiar with key organizational processes to identify problems and suggest ways to solve them. These logistics workers are clearly a good source of information on processes within their own area. However, they are less likely to understand how changes in their own work area might affect other functional areas or the larger logistics system. Therefore, the manager's task is to optimize the entire system while avoiding pitfalls such as suboptimization and inefficiencies. This study has taken an approach which uses survey information to identify where inhibiting bottlenecks exist within the organization. Then, managerial actions can be focused on the most constraining bottleneck in order gain the greatest system-wide improvement.

Background

Early situational constraint research began in the Air Force with aircraft maintenance technicians in the early 1980s. The research identified 14 constraint dimensions that affect performance, which are listed in Table 1. This work was quickly adopted by the business community.

Situational constraint theory in the Air Force was revived in 1995 at the Air Force Institute of Technology where we studied the impact of constraints on the performance of aerial port technicians. (2) A follow-up study compared the perceptions of the airmen nine months later. (5) The hope was to determine if logistics managers could be provided with a valid instrument for measuring bottlenecks within work groups to direct their attention and guide process improvement.

Methodology

The setting for this study was a large Air Force aerial port squadron. Subjects voluntarily participated in both studies with 82% of the 227 assigned personnel in the rank of airman basic to staff sergeant responding in June 1995 (184 personnel). The

Constraint Dimension	Description
1. Training	Lacked training necessary
2. Materials and Supplies	Lacked necessary material and supplies
3. Time	Lacked sufficient time to do the job
4. Tools and Equipment	Unable to perform job due to lack of proper tools and equipment
5. Planning or Scheduling	Could not complete job due to having to wait for others
6. Cooperation From Others	Unable to obtain the help from others needed to complete job
7. Personnel	Insufficient number of people present to get the job done
8. Physical Conditions	Work environment was too hot, too cold, or had too much precipitation
9. Policies and Procedures	Uncertainty concerning correct policies or procedures inhibits performance
10. Red Tape	Some aspect of rules and regulations interfered with job completion
11. Transportation	Could not get to the job site
12. Job Relevant Authority	Could not do the job because of a lack of needed authority
13. Job Related Information	Did not have enough or had wrong information
14. Forms	Lack of proper forms interfered with completing the job

Table 1. Situational Constraint Dimensions (4)

second survey in March 1996 involved 80% of the airmen (180 personnel). However, because of normal gains and attrition, only 110 individuals were identified as volunteering in both studies. The typical respondent was a male (81%), between the ages of 20 and 25 years.

A survey which was developed by O'Connor et al. was used for both studies. (4) The questionnaire consisted of 57 items representing the 14 constraint dimensions listed previously in Table 1.

Analysis

Both aerial port studies found the survey to be a useful measure of situational constraints. Internal consistency of the questions representing each constraint dimension was good, with Cronbach's alphas* ranging from 0.73 to 0.92 for the first survey and from 0.79 to 0.95 for the second survey. (3)

* Cronbach's alpha is a statistical measure which determines the degree to which a subject consistently responds to a series of questions, each designed to measure the same construct. This survey used three to six questions for each of the constraint dimensions discussed, making up the 57 items of the questionnaire. Alphas range from 0, representing no pattern of consistent responses, to 1, showing a constant response pattern. A coefficient alpha greater than 0.70 is generally considered to indicate a pattern of responses consistent enough that results can be considered reliable within a particular sample.

Four factors of individual work history and status were hypothesized to identify variance in constraint reporting. Skill level, experience (time in service), and grade were found to not have significant correlation with constraints, except for weather and time ($p < .05$). * This suggests individuals of higher rank are less affected by weather than more junior people and have more time to complete tasks. The fourth variable studied, time in work center, was highly correlated with 12 of the 14 constraint dimensions ($p < .05$). Exceptions include weather and transportation which appear to affect everyone similarly without regard to how long they have been assigned to the duty section. The significant correlations may be partially explained by an orientation process that new arrivals go through during their first several weeks in the organization. During this time, few responsibilities are usually placed on the individual and only when they become accountable for performance do they become aware of those factors that inhibit their success. Using overall constraints as a measure of this process, the level of constraints reported by respondents with various numbers of months assigned to their work center is depicted in Figure 1. Logistics managers must be aware of this effect and should only survey those individuals who are fully integrated into the organization.

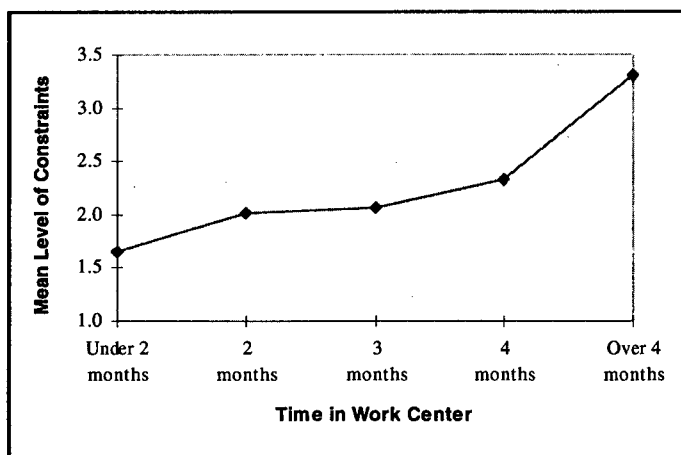


Figure 1. Overall Constraints Versus Time in Work Center

Longitudinal results found 12 of the 14 constraint levels were lower in the second survey (only authority and policies were unchanged), indicating reductions of bottlenecks within the squadron. Such results were consistent with comments of betterment within the organization as the result of several process improvement initiatives implemented during the intervening nine months.

In keeping with the goal of providing managers with information to promote process improvement, survey results were used to rank order each constraint category among all the work centers. The section with the highest reported constraints was ranked eighth on the scale of one to eight (their were eight groups). Table 2 presents the ranking for the first survey and

* The p-value is used to depict the possibility of inaccurate conclusions being made based on the limited sample size. In this instance, $p < .05$, there is no more than a 5% chance the true conclusion is contrary; therefore, we can be 95% certain the statement is accurate, even though it is impossible to statistically prove the hypothesis based on a limited sample.

Section								
	Pax	Fleet	Ramp	Spec	Cargo	Docs	Pers	Base
	Hndl						Prop	Cargo
Constraints	1	2	3	4	5	6	7	8*
Scheduling	8	7	6	1	5	2	3	
Time	5	7	6	3	2	1	8	
Cooperation	6	8	7	2	5	1	3	
Weather	6	7	8	3	5	1	2	
Transportation	5	8	7	1	3	2	6	
Authority	6	7	8	2	5	3	1	
Policy	5	8	6	1	2	7	3	
Personnel	2	3	1	5	6	8	7	
Supplies	6	7	5	2	3	1	8	
Information	5	8	7	2	1	3	6	
Training	8	5	6	1	3	7	2	
Red Tape	6	5	8	1	2	7	3	
Forms	8	7	6	2	3	1	5	

Note: 1 equals the least constrained section and 8 equals the most constrained section. Median ranking of 4 removed to allow comparison of relatively high constraints (7-8) and low constraints (1-2).

* Not enough data for comparison.

Table 2. Ranking of Mean Constraints by Section, June 1995

Section								
	Pax	Fleet	Ramp	Spec	Cargo	Docs	Pers	Base
	Hndl						Prop	Cargo
Constraints	1	2	3	4	5	6	7	8*
Scheduling	3	6	2	5	8	4	1	7
Time	2	5	3	6	8	4	1	7
Cooperation	2	5	4	6	8	3	1	7
Weather	3	8	6	4	7	1	1	4
Transportation	5	7	4	3	8	2	1	6
Authority	4	6	5	3	8	2	1	7
Policy	4	6	5	3	8	2	1	7
Personnel	3	5	4	8	7	2	1	6
Supplies	4	6	3	5	7	2	1	8
Information	3	6	4	5	8	2	1	7
Training	2	3	5	6	8	4	1	7
Red Tape	3	5	7	4	8	2	1	6
Forms	3	5	4	8	7	2	1	6

Note: 1 equals the least constrained section and 8 equals the most constrained section.

Table 3. Ranking of Mean Constraints by Section, March 1996

LEGEND	
Pax - Air Passenger Flight	Docs - Documentation Section
Fleet - Fleet Services Flight	Per Prop - Passenger and
Ramp - Ramp Services Section	Personal Property Movement
Spec Hndl - Special Handling	Section
Section	Base Cargo - Base Cargo
Cargo - Cargo Processing Section	Movement Section

Table 3 for the second. Once compiled, there are two modes of interpretation: constraints within a selected group, or a single constraint category among all sections. First, using the Fleet Services flight as an example, scanning down the column reveals bottlenecks exist in the areas of weather and transportation as evidenced by relatively high levels of performance constraints.

Second, with personnel as an example constraint and reading left-to-right across the row, the Special Handling and Cargo Processing sections have the highest personnel shortages. Although such an analysis does not guarantee any solutions, it does help by focusing the logistics manager's attention to the areas that present the greatest problems. (1)

Recommendations

Within the dynamics of an organization, a manager's role is to continually plan, implement, monitor, and react to both internal and external factors. Therefore, through appropriate manipulation of factors that promote or inhibit workers' performance, more efficient operations can be achieved. Regular administration of a survey such as O'Connor et al.'s 57-item questionnaire will provide managers with insight into which constraints exist and what their relative levels are. Managers can use this information to determine where bottlenecks are present and what types of resources are needed to clear them.

Further longitudinal analysis, including results of managerial policy and resource distribution actions, is needed to confirm the success of the method. Under such a design, effects of constraints could be compared with inhibitors that exist after each managerial treatment. Managers should determine the frequency of administration needed to provide the best results in their organization. It is also worth reiterating that workers need adequate experience on the job before they begin to recognize all the constraints present.

Before logistics managers are able to improve processes, performance inhibitors must be identified. This method provides a more detailed tool than "fire fighting" in order to establish and

focus quality initiatives. Rewards will come from logisticians solving today's bottlenecks thus making ourselves more efficient and war-ready for the future.

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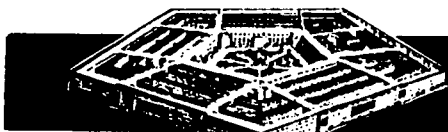
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USAF LOGISTICS POLICY INSIGHT

Air Force Transportation Home Page Now Available

For those of you who have not yet heard or have not had the opportunity to visit the Air Force Transportation Home Page, we invite you to do so. The address for the home page is: www.hq.af.mil/AFLG/LGT/ilt.html. Although the home page has a super-long address, it will provide you with information about the structure of Air Force Transportation, roles and responsibilities of the Combat Readiness, Traffic Management, and Vehicle Divisions, the Express Delivery Reinvention Laboratory, and areas of interest for the transportation community.

Links are being added on a continual basis and new features are added as the capability to do so becomes available. One such feature being looked at is the capability to download the following from the home page: Career Field Education Training Plans (CFEPTs), Enlisted Transportation Advisory Group (ETAG) minutes and Charter, and copies of transportation studies performed by the Air Force Logistics Management Agency, as well as other agencies.

Come and visit the Air Force Transportation Home Page and let us know what you think. If there is something we can add which would be of benefit to the Air Force Transportation community, please let us know.

(Capt Randy Pierce/Capt Rex Adee, HQ USAF/ILTR, DSN 225-6788, piercer@af.pentagon.mil/adeere@af.pentagon.mil)

Air Force Transportation Wins Hammer Award for Mail-Like Matter Movement (M3)

Representatives from Air Force Transportation (HQ USAF/ILT), Defense Logistics Agency (DLA), and Federal Express (FedEx) were recently presented with the Hammer Award. The

award was presented by the Deputy Staff Director, National Performance Review, Mr John Kamensky.

The Hammer Award is presented to teams of federal employees who have made significant contributions in support of reinventing government principles. The award is Vice President Al Gore's answer to yesterday's government and its \$400 hammer.

During 1994, Air Force and DLA transportation personnel tested the movement of classified two-level maintenance (2LM) items between 2LM bases and DLA depots using FedEx. This project was known as Mail-Like Matter Movement (M3). It was conducted in response to customers wanting to find faster, cheaper, yet secure ways to ship 2LM line reparable units between 2LM bases and DLA depots. Prior to this test, shipments went by US Postal Service or dedicated truck.

Success of this project was measured in money savings and shipment reliability. At the end of the test, over 2,000 classified shipments had been moved without a single loss. Moreover, the Air Force and DLA had avoided \$129,000 in costs. For the Air Force alone, 435 shipments were moved with an average savings of \$144 per shipment.

In November 1994, the Office of the Assistant Secretary of Defense, Information Warfare, Security and Counterintelligence (OASD C3I), based on the results of the M3 test, gave approval for Services to move classified cargo up to secret between DoD addresses in the continental United States (CONUS) using the General Services Administration (GSA) domestic small package express carrier. The movement of classified cargo using the GSA domestic small package express carrier has now been written into DoD Regulations and Air Force Instruction 24-201, Chapter 7, Cargo Movement.

(Lt Col Kyle Johnson, HQ USAF/ILTT, DSN 227-4744, johnsonk@af.pentagon.mil, and Capt Randy Pierce, HQ USAF/ILTR, DSN 225-6788, piercer@af.pentagon.mil)

(Continued from page 9)

The CPSC has asked the Window Covering Safety Council to change the way vinyl miniblinds are produced and eliminate the lead. Lead-free miniblinds are now available and are labeled as such. The CPSC recommends that consumers with young children remove old miniblinds and replace them with either lead-free miniblinds or alternative window coverings.

Source: "Lead Hazard from Vinyl Miniblinds." *CrossTalk*. August 1995. Produced by PRO-ACT.

The last four Environmental News articles in this issue were reprinted from Global Environmental Outreach, Volume 4, Issue 2, December 1996.

Change to the Air Force Journal of Logistics World Wide Web Uniform Resource Locator (URL)

The Air Force Logistics Management Agency recently completely changed and improved the appearance of its home page. This resulted in a change to the Agency's URL and ultimately the *Air Force Journal of Logistics*' URL as well. The new address for the Journal home page is: www.hq.af.mil/AFLG/AFLMA/AFLMA1/afjl/afjlhome.html. This address is temporary and will eventually revert to the old address: www.hq.af.mil/AFLG/AFLMA/afjl/afjlhome.html.

In Search of Focused Logistics

Lieutenant General John J. Cusick, USA
Lieutenant Colonel Donald C. Pipp, USAF

Introduction

In May 1996, the Chairman of the Joint Chiefs of Staff, General John M. Shalikashvili, released *Joint Vision 2010 (JV2010)*. (1) *JV2010* was designed to be the operational template for the evolution of the Armed Forces of the United States. The four primary tenets of *JV2010* are Dominant Maneuver, Precision Engagement, Full Dimensional Protection, and Focused Logistics (Figure 1). Judicious application of technological innovation and information superiority are billed as critical enablers of the process. A major initiative of this scope is bound to be subject to criticisms. Critics have voiced concerns that maneuver, strike, protection, and logistics are hardly “new operational concepts” and that there is an overemphasis on technology vice the human element. Objectives remain fundamentally the same. What will change is how those objectives will be achieved.

It is an indisputable fact that soldiers, sailors, airmen, and marines win wars, not technology. All the technological sophistication in the world is of little value without high-quality, trained people. However, technology enables the warfighter to accomplish the mission with increased precision, lethality, and at a lesser cost in human, political, and monetary capital. Technology goes a long way toward improving the quality of life of warfighters by allowing them to complete tasks more effectively and efficiently, and to work “smarter” not “harder.”

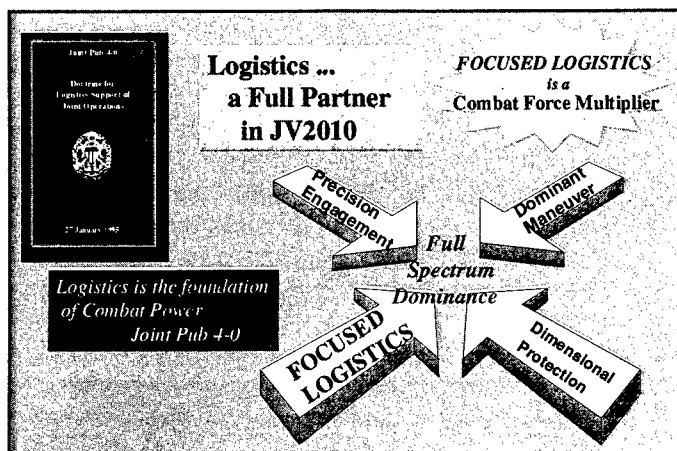


Figure 1. Focused Logistics—*Joint Vision 2010* (2)

Focused Logistics, a Full Partner in JV2010

Focused Logistics, a full partner in *JV2010*, takes an elementary issue—providing combat support to the warfighter—and launches a search for the best possible way to achieve that objective. The driving forces most often sighted for developing

Focused Logistics are downsizing, changing threat environment, technology, and political and fiscal realities. What gets little limelight is the recognition by logisticians in all the Services we can do our jobs better and we are not satisfied with the level of support we provide to the warfighter. We know we can work more efficiently, and most importantly, we have the opportunity and high-caliber people to make a genuinely evolutionary change in how we do business.

Worldwide Support to the Warfighter

Figure 2 illustrates how we foresee providing logistics support to joint operations. There is not a single point where innovative practices are not being developed or implemented by each of the Services. The US Air Force Lean Logistics and the US Army Velocity Management programs are literal springboards for quantum improvements in logistics support. Through accelerated movement of assets through transportation and repair cycles, support has improved at less cost, and confidence is building that the “system” will work when needed. Advancements in strategic lift, both sea and air, will go a long way towards providing deployability—a vital element of our future military strategy. Senior leadership has successfully campaigned for acquisition of C-17 aircraft and Roll-On/Roll Off (RORO) ships. The US Air Force Mobility Express (AMX), with integrated use of commercial carriers, is but one example of the innovations in providing the United States with unprecedented strategic force projection capability. While the elements of Joint Reception, Staging, Onward Movement, and Integration (JRSOI), Theater Distribution, and Joint Theater Logistics Command and Control (Joint Theater LOG C2) have yet to be finalized, there is unanimous agreement on the need to more clearly define roles and responsibilities in these critical elements of the force projection and near term resolution is probable.

Supporting the entire network from source of supply to point of need will be the Global Combat Support System (GCSS). GCSS is designed to do for the logistician what the Global Command and Control System (GCCS) does for the operator. GCSS will facilitate access to critical resource data anytime, anywhere, throughout the world, and will not require a specific hardware suite to make it all happen. Developments in Joint Total Asset Visibility (JTAV) and In-transit Visibility (ITV) will culminate in quantum leaps in the effectiveness and efficiency of logistics support to the warfighter by providing critical resource information throughout strategic, operational, and tactical levels of any military engagement. Each of the Services has its methods for ensuring logistics connectivity and resupply to deployed forces. The problem often stems from the fact that methods often vary by Service and sometimes by unit. GCSS will provide logisticians much needed visibility of critical resources

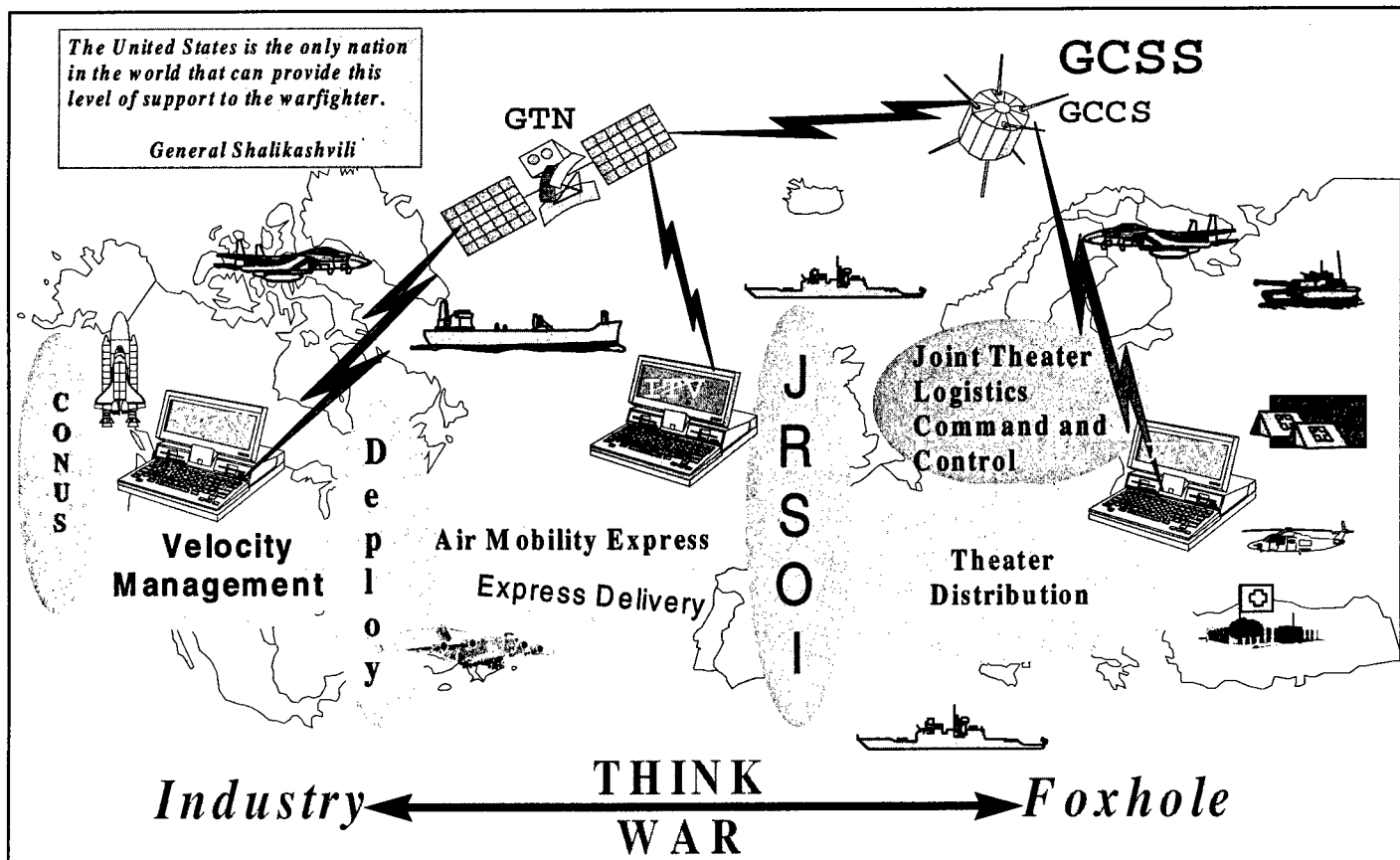


Figure 2. Worldwide Support to the Warfighter (3)

in factories and wholesale locations, in-transit to and from the theater, and in storage at units both in and out of the theater. The days of multiple requisitioning of an item, in hopes at least one will arrive when needed, will become a thing of the past. The logistics footprint of the future will be a more precise balance between Just in Time and Just in Case equals Just Enough. Developments in Automated Information Technology (AIT) are just now beginning to emerge that will provide automated tracking of assets throughout the world. Incorporation of AIT requirements into the acquisition process could provide worldwide visibility of assets throughout their life cycle. All these efforts are noble indeed, but are of little consequence unless conscious efforts are made to monitor progress through to completion.

Focused Logistics Action Plan

The Joint Staff Logistics Directorate (J4) is developing a Focused Logistics Action Plan (Figure 3) that identifies a host of joint logistics initiatives designed to improve support to the warfighter. Focused Logistics takes its cue from the Joint Warfighting Capabilities Assessment (JWCA) and the Joint Monthly Readiness Review (JMRR) processes. Through these processes, the Commanders in Chief (CINCs) and the Services articulate issues which they feel have adverse impacts on their capability. While the programs require intensive management, they have already proven their worth as a vehicle for channeling and resolving joint issues. The JWCA and JMRR processes have resulted in considerable cost savings, improved support to the CINCs, contributed to our goal as the world's premier deployer, and have made significant contributions to joint logistics

operations (Figure 4, next page). While JMRR/JWCA is a key element of the process, it is by no means the only one.

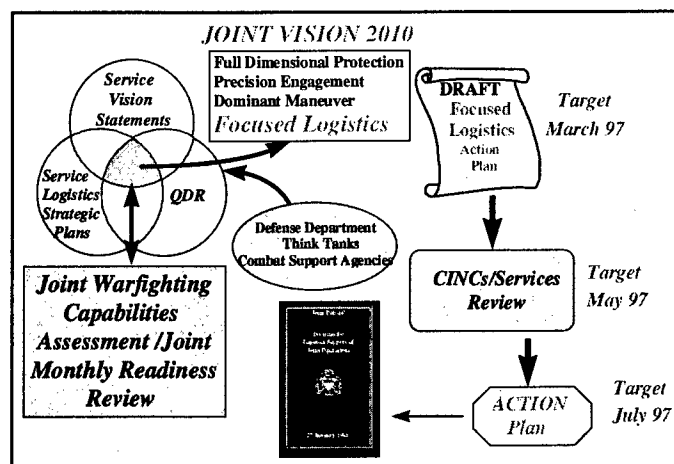


Figure 3. Focused Logistics Action Plan

LEGEND

CINCs - Commanders in Chief
CONUS - Continental United States
GCSS - Global Combat Support System
GCCS - Global Command and Control System
GTN - Global Transportation Network
ITV - In-transit Visibility
JRSOI - Joint Reception, Staging, Onward Movement, and Integration
JTAV - Joint Total Asset Visibility
QDR - Quadrennial Defense Review

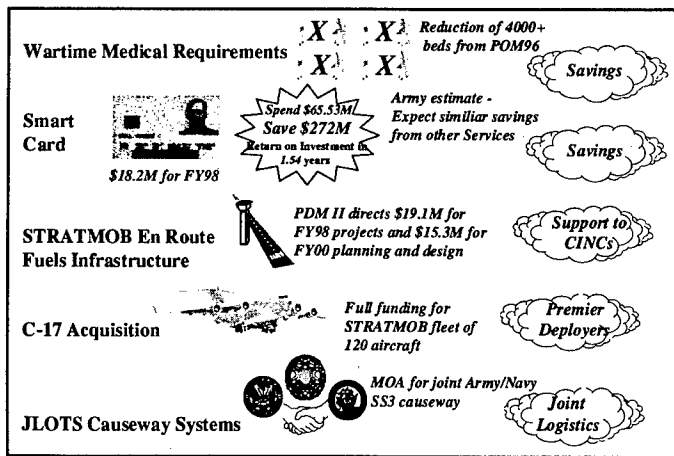


Figure 4. Recent Joint Warfighting Capabilities Assessment Successes

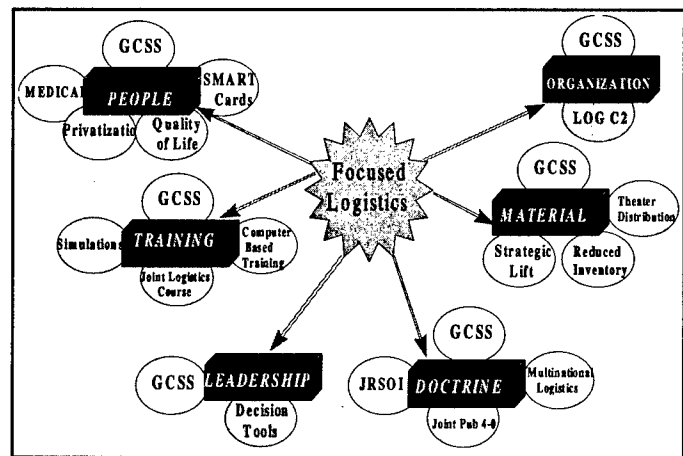


Figure 5. Impact of Focused Logistics

LEGEND

CINCs - Commanders in Chief
FY - Fiscal Year
GCSS - Global Combat Support System
JLOTS - Joint Logistics Over the Shore
JRSOI - Joint Reception, Staging, Onward Movement, and Integration

LOG C2 - Logistics Command and Control
MOA - Memorandum of Agreement
PDM - Program Decision Memorandum
POM - Program Objective Memorandum
SS3 - Sea State 3
STRATMOB - Strategic Mobility

Strategic guidance such as the National Military Strategy (NMS), Joint Strategy Review (JSR), *JV2010*, and ongoing dialogue of the Quadrennial Defense Review (QDR) served as the baseline for developing the Focused Logistics plan. Meanwhile Service vision statements, and strategic logistics plans of the CINCs, Services, and Office of the Secretary of Defense (OSD) were reviewed for common themes and innovative concepts, with the intent to draw from the many talents of strategic planners across the Services. Other sources included the exceptional work done by the Defense Science Board and think tanks, and the extraordinary work done by the Joint Warfighting Center at Fort Monroe, Virginia. Target date for publishing the plan is summer 1997 after extensive coordination with the CINCs and Services.

Evolving concepts effect multiple dimensions of an operating environment and Focused Logistics is no exception. Focused Logistics has significant ramifications for Doctrine, Organization, Training, Material, Leadership, and People (Figure 5). Not surprisingly, GCSS provides a common thread throughout each of these areas. Focused Logistics will have positive effects on a Service member's quality of life through a vastly improved work environment: developments in computer based training, increased use and more reliable modeling and simulations, development of state of the art decision tools, medical readiness, asset visibility, and Smart card technology. Logistics organization structures will be streamlined as we right-size the logistics footprint and make genuine progress in such vital areas as logistics command and control and theater distribution. Logistics doctrine is being reviewed and modified as necessary to keep pace with rapid developments and provide overarching guidance regarding traditional as well as developing capabilities.

Summary

The Focused Logistics Plan will be a concise publication of joint logistics issues of highest concern to the CINCs and Services as identified through the JWCA process. It will provide logisticians a concise overview of key issues and projects under development on behalf of the joint logistics community. It will provide metrics, to the extent possible, for projects and programs identified in the plan. It will be a think piece for CINCs and Services to use to develop and/or review their own strategic logistics plans.

The Focused Logistics Plan will be a living document and as such will be subject to changes, additions, and deletions as events dictate. The utility and effectiveness of the plan will not be determined by how many screens, pages, or graphs can be produced. Effectiveness will be determined by validated progress on identified programs. Focused Logistics is not the latest "fad" to be passed with the introduction of a new regime. It is a plan of action as well as a state of mind that we must perpetuate throughout the joint logistics community. Focused Logistics is a dynamic plan of action for combat support to the warfighter.

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3. Shalikashvili, John M, Gen, USA. Statement made during a Chairman of the Joint Chiefs of Staff offsite meeting, Aug 96.

Lieutenant General Cusick is presently the Director for Logistics at the Joint Staff, Washington, DC. Lieutenant Colonel Pipp is presently the Focused Logistics Project Officer in the Readiness and Requirements Division of the Joint Staff Logistics Directorate.





CAREER AND PERSONNEL INFORMATION

Logistics Professional Development

How Do I Gain Acquisition Logistics or Program Management Experience?

For those logistics officers wishing to gain acquisition logistics or program management experience, and become certified in the Acquisition Professional Development Program (APDP), there are opportunities to do so. Those opting to pursue a career path leading to and including acquisition-related assignments later in their careers should begin gaining the appropriate experience at the company grade and junior field grade levels. The questions and answers discussed below are provided to help logistics officers in making decisions about whether or not to seek this type of experience and, if so, begin to plan their career paths accordingly. Here are the answers to some commonly asked questions.

Question: How do I gain acquisition logistics or program management experience? There are different ways you can gain acquisition logistics or program management experience. The primary way is to apply and be selected for acquisition logistics or program management coded positions within the logistics career fields. There are over 540 maintenance, logistics plans and programs, supply, and transportation positions that are acquisition logistics or program management coded. Of these, 202 are maintenance, 183 are logistics plans and programs, 94 are general logistician (21L), 46 are supply, and 16 are transportation positions. Company grade and junior field grade officers without APDP experience typically can enter APDP Level 1 coded positions, and while in them, work towards obtaining APDP certification, as applicable. Different levels of certification require various amounts of specific experience, training classes, and possibly college courses.

If you are having difficulty finding an APDP-coded job in your core logistics Air Force Specialty Code (AFSC), you could pursue APDP-coded positions in another logistics AFSC—as part of the Deputy Chief of Staff, Installations and Logistics (HQ USAF/IL) Logistics Cross Flow program. A transportation officer, for example, who would like to pursue APDP certification, might attempt to cross flow into a maintenance or logistics plans and programs position that is APDP-coded. With a combined total of over 380 coded positions between these two AFSCs, this would potentially allow the transporter (whose career field has only 16 coded positions) a much greater opportunity to gain acquisition experience and pursue certification. At the same time, the officer would be gaining valuable experience in another logistics discipline.

Another possible method for you to gain acquisition experience is to try to cross flow into the acquisition (63XX)

career field for an assignment (most of these positions are APDP-coded). For this to occur, your career field manager at the Air Force Personnel Center (AFPC) would have to release you to compete for an acquisition job (not likely because of current manning levels within the logistics career fields). Additionally, many acquisition jobs require officers with more technical expertise and/or educational backgrounds than logistics officers typically possess. Therefore, even if you are released to compete for 63XX jobs, you are often not as competitive as acquisition officers who normally possess the more technical backgrounds the hiring authorities are looking for.

Finally, in a few special circumstances, you may be able to gain APDP credit even if you are not in an APDP-coded position—if you are performing program management or acquisition logistics type duties. While it may be more difficult for you to obtain the necessary training classes (because officers in coded positions are given priority), you may eventually complete the training and then apply for certification through your major command (MAJCOM) APDP focal point. This, in turn, might qualify you for future, higher-level APDP positions.

Question: Who do I contact? To pursue an APDP-coded job on a permanent change of station (PCS) basis, you should first identify advertised jobs you are interested in (for officer professional development (OPD) purposes) that are also APDP-coded. Entry level APDP-coded positions are normally advertised as requiring Level 1 certification, although not always. If you are unsure whether a position is coded, you can contact the applicable AFPC assignment officer listed on the particular job advertisement. You volunteer for these jobs in the same way you volunteer for any other advertised job. Logistics assignment officers at HQ/AFPC are listed below.

Branch Chief

Lt Col Edward Hayman, DSN 487-3556, haymane@hq.afpc.af.mil

Maintenance Assignments

Capt Marc Novak, DSN 487-3556/4553, novakm@hq.afpc.af.mil

*Capt Wes Norris, DSN 487-3556/4553, norrisw@hq.afpc.af.mil

Capt Ray Roessler, DSN 487-3556/4553, roessler@hq.afpc.af.mil

Logistics Plans and Programs Assignments

Capt Rick Cornelio, DSN 487-5789/5788, cornelir@hq.afpc.af.mil

Capt Keith Quinton, DSN 487-5789/5788, quintonk@hq.afpc.af.mil

Supply Assignments

Maj Craig Bond, DSN 487-6417/6418, bondc@hq.afpc.af.mil

Capt Debbie Elliot, DSN 487-6417/6418, elliotd@hq.afpc.af.mil

Transportation Assignments

Capt Tom Jett, DSN 487-4024, jett@hq.afpc.af.mil

Capt Ken Backes, DSN 487-4024, backesk@hq.afpc.af.mil

*Works AFMC assignments.

To pursue an acquisition position on a permanent change of assignment (PCA) basis, you should identify which APDP-coded

vacancies exist in your unit. You should discuss your career objectives with your supervisor and solicit his or her assistance. Officers without acquisition experience can potentially PCA into entry-level vacancies. Those with some certification may be able to PCA into APDP positions that require more acquisition experience.

Question: How do I get scheduled for classes? AFPC does not get involved in scheduling officers for acquisition training. According to the Acquisition Development Program Guide, acquisition training office (ATO) personnel schedule individuals for acquisition training through the MAJCOM Director of Personnel (DP) acquisition training officer, MAJCOM functional points of contact, base training offices, and functional acquisition training representatives. Your MAJCOM APDP focal point should be able to tell you specifically who you need to contact to get scheduled for training.

Question: Who do I send my paperwork through to get the different certification levels? There is lots of great, detailed information available on the Internet that covers APDP certification. The address is: www.safaq.hq.af.mil/safaq/acq_workf/certification. The information contained at this Internet site includes a list of APDP MAJCOM focal points and Air Staff and Secretariat functional managers. If your MAJCOM, field operating agency (FOA), direct reporting unit (DRU), etc., does not have a certification authority, you should send your application to the appropriate Air Staff or Secretariat functional manager. To determine specific application procedures, contact your base or MAJCOM function representative (or Air Staff functional manager if appropriate).

Within Air Force Materiel Command (AFMC), the APDP focal points (Lt Col William Gaillard and Capt Jose Caussade, HQ AFMC/DPEP, DSN 787-0125) review Level III certification requests only. The command has delegated review authority for Levels I and II certification to the field. If you are assigned to AFMC, Lt Col Gaillard recommends you contact your local center or base APDP focal points for specific instructions. If you are unable to get the required information at that level or have other questions, call the APDP hot line number, 787-APDP, for assistance.

Before you apply for certification, you should check applicable certification standards. Certification requirements for the various APDP program levels and tracks are also listed on the Internet at: www.acq.osd.mil/dau/appg.html.

Question: Is this necessary for my career? Depending on the career path you want to pursue, APDP certification may or may not be necessary for continued, successful career development. Some paths to fully successful logistics careers probably will not require certification. However, if your career goal is to become a program manager or more senior acquisition logistics officer, then you should plan to gain APDP experience beginning at the company grade and junior field grade level. It may also be wise for you to increase your future career options by gaining the required APDP experiences and certifications if possible (while following good OPD principles) at the company grade and junior field grade level. Although you may not plan to pursue program management or acquisition logistics opportunities at the Lt Col level, they may turn out to be the

best career options for you at that time. Without some previous APDP experience, it would be less likely you would be selected for one of these jobs, therefore your career options could be limited.

Question: What types of jobs does this open up for me? The majority of acquisition logistics or program management coded logistics (21XX) positions are located within AFMC's Air Logistics Centers (ALCs) and Product Centers. At the Lt Col grade, qualified logistics officers might fill jobs as ALC division or branch chiefs, and work in various weapon or software system program offices (SPOs). AFMC would be the best source of information on career opportunities within that command. You can contact the logistics assignments branch (HQ AFMC/DPAO, DSN 787-2125) at Wright-Patterson AFB, Ohio, for information. Additionally, senior logistics officers within AFMC can provide valuable career counseling to interested officers.

Logistics officers who obtain acquisition logistics and/or program management experience gain valuable insight into these important processes. These officers typically develop a broader understanding of the overall logistics support picture, which can improve the officer's effectiveness as a senior logistician. For those wishing to pursue this type of career path or wanting to increase their career options at the Lt Col level, there are some great APDP opportunities available.

(Capt Debbie Elliot, HQ AFPC/DPASL, DSN 487-6417, elliott@hq.afpc.af.mil)

Civilian Career Management

Logistics Civilian Career Enhancement Program Whole Person Score on the World Wide Web

The Logistics Civilian Career Enhancement Program (LCCEP) is pleased to announce the LCCEP Whole Person Score (WPS) is now available to registrants on the World Wide Web. Shortly after the LCCEP WPS was implemented in 1992, registrants received a summary of their WPS in the mail. Over the years, additional information was included in this annual mailing, such as the WPS Pocket Guide that described how to compute a WPS, and a table that showed how registrants compared in each of the WPS elements. Now, everything previously mailed for the WPS is on the World Wide Web, including the personal WPS summary. You can reach the WPS Web Page through the LCCEP home page. The LCCEP Web Site address is: http://www.afpc.af.mil/civ_car/lccep.

The Individual Whole Person Score Summary is accessed by entering your social security number (SSN) and personal identification number (PIN). Initially, the PIN is your birth date in the format YYMMDD. The information returned over the Internet to you will not include your SSN. The advantages of this new web site feature is the ability to check your WPS any time and to receive information that is current as of the previous "end-of-month." For the Air Force, the web site eliminates over 50,000 pieces of paper and saves a considerable amount in printing, handling, and mailing costs.

(James A. Boyd, HQ AFPC/DPKCLR, DSN 487-5351)

Wargaming Logistics for Strategic Leaders

John Auger

It is a cold March day as you leave your Pentagon office for your official office call with your new boss, the J4. As you walk the E Ring to her office, you meet several people you served with when you were assigned to the Office of the Deputy Chief of Staff, Logistics during your third tour in Washington. They congratulate you on your recent assignment to the Joint Staff. As you catch up on old times, talk turns to the headlines in the morning's *Early Bird*.¹ Things are starting to heat up again in the Middle East, the on-going US commitment in Bosnia is again turning sour, and there are ominous rumblings in North Africa that could require a US response. Upon arriving at your destination, the executive officer quickly ushers you in to see the J4 who rose to greet you and tell you how delighted she is that you are on her team. She quickly outlines some major issues facing the Services and asks you to represent her in an OPSDEPS² meeting in the Tank³ that afternoon. Earlier in the morning the J3 asked her to provide an assessment to the group on the ability of the US to respond to two major crises as well as a number of simultaneously occurring lesser contingencies. She was planning to attend the meeting herself, but the Chairman just called her and asked her to accompany him to testify on the Hill. Welcome back to the Pentagon you think. Fortunately, you are trained and educated for just this situation. Ten years earlier the Air Force sent you to study at the Army's War College in Carlisle, Pennsylvania. One of the rights of passage there is the Strategic Crisis Exercise that placed you in a very similar predicament. It looks as if what you learned is about to come in handy. As you hurry back to your office, you recall the words of your favorite 20th Century philosopher, Yogi Berra, "It looks like déjà vu all over again."

Introduction

The US Army War College uses a Strategic Crisis Exercise (SCE) to synthesize the curriculum for its students. The SCE is a free-play, fully-automated, computer-aided, joint and multinational exercise which brings together in a gaming context, the strategic-level education imparted to players by the War College during the academic year. In the exercise, students play a variety of roles, including Joint Chiefs of Staff and

functional and area theater command staffs. In addition there are agency roles, including the Departments of State, Commerce, and Treasury, among others. The students are lieutenant colonels, colonels, and sea service equivalents, who are from the active and reserve components of all branches of the armed services, high ranking international officers from forty nations around the globe, and senior civilians from agencies throughout the federal government.

The exercise is designed so the student can apply national and theater military strategies within the framework of the joint crisis action planning process. Exercise objectives include examining the US National Security and National Military Strategy; testing force adequacy for multiple crises; examining reserve component employment issues; and analyzing the four military Services' ability to mobilize, train, and sustain their forces. Additionally, the students look specifically at three areas of strategic level logistics: the defense industrial base and its impact on sustainment and the subsequent reconstitution of new forces, strategic medical issues, and strategic mobility.

To accomplish these objectives, the War College's Center for Strategic Leadership developed a political-military exercise that applied joint and service doctrines in a broad range of crisis scenarios. They included two major regional contingencies (MRCs) and eight near simultaneous lesser incidents spanning all five unified commands. The scenarios addressed the entire spectrum of military operations from humanitarian assistance and disaster relief through peacekeeping and peace enforcement missions to full-scale conventional warfare, including some weapons of mass destruction play. The scenarios were set in the year 2006 and included 2006 force structure, equipment, and doctrine. To provide a plausible backdrop, a World Summary 2006 was written. World Summary 2006 is a game document written for the players to portray a plausible accounting of the political, economic, social, and military changes that had occurred globally between 1996 and the exercise which was set in the year 2006. The world summary was complemented by a national security strategy and a national military strategy modeled closely on the contemporary strategies but updated to reflect the global political environment in the year 2006. The students were divided into three similar groups and each group devised its own unique approach to the situations it was confronted with. The exercise was conducted over ten class days with the game itself spanning 230 game days to allow adequate time for planning, mobilization, strategic deployment, and strategic and operational employment. As each student team confronted the simulated world crises, it was required to deal with diplomatic issues, domestic political accountability, interagency response coordination, and the deployment, coordination, and support of forces. Players solved the issue of multitheater demands on forces, air and sealift, and sustainment assets. Thus they were

1. A publication prepared daily by the Armed Forces Information Service that brings news items of interest to the attention of key personnel. The *Early Bird* consists of articles clipped from the nation's major newspapers and other sources.

2. The OPSDEPS are the operational deputies of the Joint Staff and the Services: the J3; the Deputy Chief of Staff, Plans and Operations (Air Force); the Deputy Chief of Staff for Operations and Plans (Army); Deputy Chief of Naval Operations Plans, Policy, and Operations (Navy); and the Deputy Chief of Staff for Plans, Policies, and Operations (Marine Corps).

3. The "Tank" is the nickname for the Pentagon Meeting Room used by the Joint Chiefs of Staff to discuss matters of the highest national security.

explicitly forced to address real constraints on their ability to deploy forces to theater and support them once there. Disruptions in routine supply patterns, including an earthquake along the New Madrid Fault, which encompasses a key ammunition producing and chemical storage region of the US, and a global oil crisis, compounded resource constraints and further stressed student resource planning. The earthquake coincided with the end of the first MRC in Algeria and the outbreak of the second MRC in Southwest Asia. The earthquake raised the issues of damage to multiple ammunition plants in the area, and loss of containment of chemical storage facilities, requiring diversion of chemical suits to the continental United States (CONUS). Similarly, an oil crisis, precipitated by the start of the second MRC in the Persian Gulf and the closure of the Strait of Hormuz, threatened to undermine the cohesion of the allied coalition, expand resource constraints on US forces, and disrupt the US and world economies.

Defense Industrial Base

To analyze the impact of these myriad events, The Army Industrial Base Assessment Model (TAIBAM) was used. TAIBAM provides planners with a flexible, easy to use, analytical tool, which allows them to assess the impact of various future warfare industrial requirements under different budget and economic forecasts on specific sectors of the defense industrial base critical to the accomplishment of wartime missions. Although TAIBAM is currently configured to assess the impacts on the Army's ability to accomplish its Title X wartime mission, it can also be configured to support the analysis of the other Services' ability to execute their Title X responsibilities.* The model is designed to capture, at an aggregate level, the fundamental processes by which decisions made by strategic planners today impact on the industrial base. TAIBAM's matrix logic allows planners to vary most of the fundamental structural parameters which drive the industrial base's performance and measure that performance in relation to the requirements of a variety of specific wartime scenarios. TAIBAM's principal entry point is the force requirements and parameters established by the Defense Planning Guidance in conjunction with a variety of wartime scenarios. The model allows wargamers and others to calculate near instantaneously the ability of the industrial base to respond to reconstitution demands, particularly those system replacements demands arising from the conflict which they model. Many of the user alterable defaults in TAIBAM are budgetary and thus allow a quantitative comparison between alternative allocations of resources with respect to a scenario or other specific defense industrial base requirements. Other user alterable defaults allow similar quantitative assessments between various defense industrial base management strategies, such as changing the percentage of the force to be rebuilt, lengthening the target reconstitution percentage, expanding the dual use capability of specific industries, etc. The model can be run on any authorized user's desktop computer, and thus provides a common framework by which planners from various different

policy perspectives can quantitatively analyze the defense industrial base implications of their decision.

In addition to performing the defense industrial production analysis for which it was designed, TAIBAM performed other useful educational functions during the exercise. Its inventory, ramp-up rate, cost data, and other worksheets provided a useful database for both exercise controllers and student cells. Extracts from these sheets were used by the Service chiefs' cells in preparation for their testimony to Congress. TAIBAM also translated computer-derived attrition data percentages into specific numbers that were used to provide numerical attrition reports back into the exercise to the student players. These equipment loss and damage functions were also drawn upon to derive estimates for the number of US military personnel killed and wounded. Additionally, TAIBAM's "Mean Miles Between Failures" database for wheeled and tracked combat vehicles and estimates of vehicle miles driven allowed the TAIBAM team to estimate the number of wheeled and tracked combat vehicle breakdowns and the resultant maintenance demands during the exercise. Using a baseline of costs incurred during Operations DESERT SHIELD and DESERT STORM as a reference point, the cost of replacing expended ammunition for the first MRC was calculated to provide the students with a better appreciation for the fiscal impact of their operations. TAIBAM also provided defense budget projections, scenario cost data, and projected sector capacities and shortfalls to the Departments of Commerce and Treasury cells in support of their economic and industrial analysis missions. TAIBAM was used to provide data on the surge multipliers for oil extraction and refinement industries. This data supported the efforts of the Department of Commerce cell to estimate the ability of US production capacity to make up for disrupted Persian Gulf oil supplies.

In the SCE, real resource constraints were introduced as issues the students needed to address. TAIBAM, other War College models, and the Defense Logistics Agency Industrial Analysis Support Office (IASO) databases provided specific, realistic data which outlined these constraints and helped students formulate workarounds. Defense industrial base and sustainment issues were built into questions posed to the Service chiefs during congressional testimony, requiring each team to deal with these issues in preparation for those mock hearings. Additionally, the IASO munitions status reports indicated the constraints on each team because of limited stockpiles of preferred munitions, limits on production of these munitions, and the impact of joint service and allied demands on the munitions industrial base. These resource constraints in the joint context required the students to convene a Joint Materiel Priorities Allocation Board to allocate scarce preferred munitions across theaters.

Strategic Medical Issues

Medical play focused on the development of theater casualty estimates, and the presentation and defense of these estimates through the military chain of command, congressional hearings, and press briefings and conferences. The players became acutely aware of how critical and sensitive these issues were to a concerned public and their elected representatives. A parallel lesson learned was the need to establish a unit and personnel rotation policy for extended deployments and the need for the

* Title 10, United States Code, contains the organic law governing the Armed Forces of the United States and provides for the organization of the Department of Defense, including the military departments.

timely return and demobilization of reserve component units once they were no longer essential to ongoing military activities. Theater medical support plans were developed to include casualty rates and the level of medical threat, in-theater hospital and evacuation requirements and constraints, and strategic evacuation requirements. The rapid pace of the game with time jumps of as much as 60 days did not afford planners the opportunity to address these issues in detail, but it did place them on the table for discussion and further consideration. Subissues that were raised but not examined included: refugee and prisoner of war health care; the deployment of Navy hospital ships and the effect on naval CONUS medical staffing; the ability of the Army to serve as a theater joint medical logistics manager; the use of new medical technologies and medicine, such as telemedicine, telepresence, jointly staffed treatment facilities, etc.; the coordination of medical regulating and strategic evacuation issues with Transportation Command; and host nation and allied medical support issues. The major earthquake scenario that was centered on the New Madrid Fault exacerbated the issue of CONUS medical care delivery. With large numbers of active and reserve medical personnel and units deployed in support of two MRCs and a number of lesser regional contingencies, the impact on care to CONUS beneficiaries and the ability of TriCare* wraparound contracts to maintain a high level of care was significant and this was driven home to the players.

The implications of the use of weapons of mass destruction (WMD) for medical planning and operations was another clear lesson for the exercise players. Given the suspected widespread development of chemical and biological weapons among several potential contemporary adversaries—Iran, Iraq, and Libya, to name but a few, and the proliferation of nuclear weapons worldwide, the consequences of the play of WMD was all too real for the students. The necessity for rapid and effective treatment and evacuation for casualties from these weapons was a lesson learned. Another clear message for the players was the political sensitivity of immunization policies for troops who were to be deployed to areas where the threat of the use of these type weapons was considered high. Most decisions concerning medical care both overseas and in the CONUS were subjected to intense scrutiny both in the media and by elected representatives. As each of the parallel games wrestled with these issues in slightly different ways, the players' initial decisions impacted on later occurring events.

Strategic Mobility

Players used a Crisis Action Model (CAM) to analyze the impact of these multiple crises on strategic lift capabilities. CAM is an educational tool which is used to deploy forces and supplies to one or more theaters during strategic campaign planning exercises. The combination of supply levels achieved in a theater

* TriCare is a medical program for active-duty, retired, and family members of all military services. It is the Department of Defense's response to the rapidly rising cost of health care and the closure of military bases with their associated medical treatment facilities. TriCare is designed to expand access to care, assure high quality care, control health care costs for the patient and the government, and improve medical readiness. The program is managed by the military and supported by civilian contractors. TriCare began in March 1995 and will be fully implemented by November 1997.

and closure rates of particular units determine whether a campaign plan is supportable. Specific decisions made by the players included: which seaports and airfields were to be used by US forces, when and to what degree should there be a mobilization of airlift and sealift, what should be the apportionment of air and sealift to specific theaters, and how many days of supplies were desired in each theater. Primary constraints affecting supply levels and unit closure were number of aircraft and ships mobilized, percentage of aircraft and ships apportioned to a theater, time required by the different types of lift to be available after mobilization, and throughput capacity of airfields and seaports (personnel, dry cargo, unit equipment, and fuel). Resolution of units was typically squadron level for air forces, division or brigade level for ground forces, and task force level for naval forces.

Players learned that their campaign plans had to be tailored to accommodate the multiple demands that were being made on strategic lift assets. Students were able to accomplish their assigned missions by relying heavily on assistance from allies and by mobilizing Civil Reserve Air Fleet (CRAF) I and CRAF II assets.* Because of the tremendous economic impacts of a CRAF III mobilization, it was not used. Selected vessels from the Ready Reserve Force were used to augment strategic sealift assets. Players were assisted in their transportation efforts by virtually unrestricted overflight and uninhibited freedom of navigation. Plans for future exercises include complicating strategic lift operations by denying overflight rights, limiting the assistance provided by allied nations, and delaying reserve transportation assets mobilization decisions.

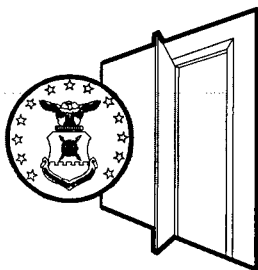
Conclusion

Most students had not been forced to confront such a myriad array of logistical constraints and very, very few have had to confront strategic-level logistics issues. The necessity to prioritize between the civilian sector and defense on the one hand, complicated within defense by the need for prioritization among theaters and between services, and further exacerbated by the need to provide some degree of logistic support to allies and coalition partners, exposed students to a host of issues they had not previously been forced to confront. Even the limited logistics play in the SCE proved to be a valuable lesson in

(Continued on bottom of page 41)

* The Civil Reserve Air Fleet (CRAF) is a voluntary program which provides commercial augmentation of military airlift capability during contingency or crisis operations. Carriers who sign up for any of the three specified stages are subject to call-up based on a contractual agreement with the Department of Defense. Airlines commit specific aircraft, crews, and their support assets to the CRAF program to support mobilization. In return for their voluntary pledge of aircraft to the program, airlift carriers are eligible for a portion of the government's peacetime airlift business. During national emergencies, CRAF can be activated in three stages to meet the need for airlift. Stage I and II may be activated by the Commander in Chief, United States Transportation Command, with Secretary of Defense (SECDEF) approval. Stage I is composed of long range, intercontinental capable assets only and carriers are given a minimum of 24 hours, from mission assignment, to respond to the initial upload site. Stage II activation is normally associated with partial mobilization. Stage II has a 24-hour response time after mission assignment. Finally, the full CRAF capability is represented in Stage III. The SECDEF must issue the order to activate Stage III which is the total activation of all CRAF carriers during a national emergency. A main factor limiting CRAF use during a major regional contingency is that the CRAF crews are not required to enter threatening environments.

AFIT



The Doorway to Logistics Success

Graduate School of Logistics and Acquisition Management

The Graduate School of Logistics and Acquisition Management (AFIT/LA) is the graduate school of management for the United States Air Force. The school's mission is to provide uniquely defense-oriented graduate education in logistics and acquisition management to Air Force and Department of Defense (DoD) leaders. Through high quality graduate instruction, faculty and student research, and faculty consultation, the Graduate School of Logistics and Acquisition Management provides the Air Force and DoD with state-of-the-art management knowledge and tools to solve defense acquisition and logistics problems.

The Graduate School of Logistics and Acquisition Management incorporates two teaching departments, each of which manages various master's degree programs. The Department of Graduate Logistics Management (AFIT/LAL) offers programs leading to a Master of Science degree in Logistics

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Logistics Lessons Learned Award

The Air Force Historical Foundation has selected "Logistics Lessons From the Past—Deployed Operations" (Summer-Fall 1996), written by Group Captain Peter J. Dye, RAF, as the best *Air Force Journal of Logistics* article that contains logistics lessons learned for FY 96.

What to Do With the Truck?—The Air Service of the AEF and the Limits of Organic Transport, 1917-1918

Roger G. Miller, PhD

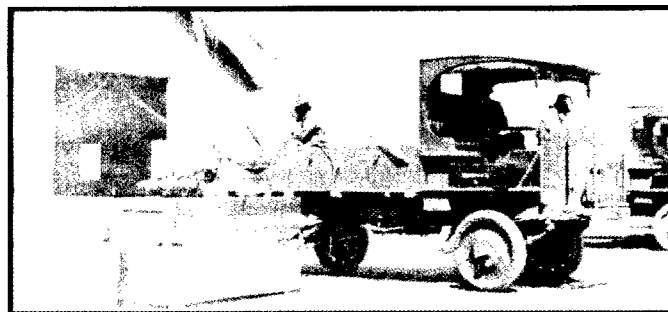
It is rare that a US Air Force historian places the lowly motor truck on a level of interest above that of the airplane, but in the earliest days of our history when the aircraft's operational range was severely limited, the mobility of the flying squadrons was of vital importance. Prior to World War I, the US Army's first operational air unit, the 1st Aero Squadron, found its answer to mobility in the four-wheel drive motor truck. Moreover, the squadron's experience with that vehicle laid the foundation for the acceptance of truck transport by the US Army in place of animal-drawn transport, a development which took place during Brigadier General John J. Pershing's Punitive Expedition into Mexico in March 1916. Before the Punitive Expedition, animal-drawn transport predominated in the US Army; afterward, the truck was ascendant, and the 1st Aero Squadron was an instrument in that profound change. A question went unanswered in Mexico, however: should an aviation service operating as a branch of the Army have its own private, organic ground transport independent of the rest of the Army? That question could be ignored as long as that unit functioned as part of a small field force. It assumed dramatic significance, however, when the American Expeditionary Forces (AEF) assembled in France during World War I.¹

The US Army had begun experimenting with motor vehicles as early as 1900; the General Staff began a systematic study of truck transport in 1911; and army leaders accepted the value of motorized transportation by 1916. Nevertheless, limited funding and the military's innate conservatism delayed widespread use. At a time when thousands of trucks were supporting the armies in Europe, the US Army owned about 100 trucks from at least 20 different companies scattered at posts and depots across the country. Additionally, while the Quartermaster Corps had set specifications for a field truck and proposed a tentative organization for motor truck supply companies and repair shops, the Corps had yet to adopt a standard truck, and Army personnel were neither trained nor experienced in the management, operation, and maintenance of motor vehicles.²

Aviation personnel in the Signal Corps, on the other hand, had become interested in trucks almost as early as in airplanes. Lieutenant Benjamin D. Foulois, for example, who flew the Army's first airplane at Fort Sam Houston, Texas, in 1910, included a requirement for ten "aero trucks" and ten "auto trucks" in the provisional regulations for airplane operations that he wrote early in 1911. The development of aviation truck transport was intimately tied to the organization of an airplane unit for field service, which took place in 1913 with the establishment of the 1st Aero Squadron. The tables of organization for the squadron authorized it 16 motor trucks to enable the unit to cooperate with the Army in the field. The squadron received its first trucks in mid-1914, and had a total of 11 by early 1915.

Subsequently, beginning in July 1915, the 1st Aero Squadron operated its vehicles under field conditions at Fort Sill, Oklahoma, and across country between Fort Sill and San Antonio, Texas, developing in the process, practical expertise in administering, operating, and maintaining motor trucks. This experience proved vital during the Punitive Expedition.³

On March 9, 1916, the Mexican insurgent, Francisco "Pancho" Villa, attacked Columbus, New Mexico, killing several civilians and soldiers. The War Department quickly organized an expedition into Mexico under "Black Jack" Pershing. Denied the use of Mexican railroads by the Mexican government, Pershing determined to use motor trucks to support his force. At this point the 1st Aero Squadron's experience with motor vehicles became indispensable for three reasons. First, the commander, now Captain Foulois, made the squadron trucks and drivers available for hauling supplies and personnel to the Punitive Expedition's southbound columns. For the first few days of the advance, from March 15 through March 19, the 1st Aero Squadron trucks provided the only motorized supply capability for the Punitive Expedition. Second, Foulois was placed in temporary charge of the Expedition's motor transportation during that same period. Third, when the trucks special-ordered by the Army began arriving on March 18, they were unassembled and important parts were missing. Since the quartermaster personnel at Columbus lacked the knowledge and tools to prepare the vehicles, the 1st Aero Squadron filled those requirements. In all, aviation personnel assembled 54 trucks, providing the Expedition with its first two complete quartermaster truck trains and alleviating Pershing's immediate supply problems.⁴



Moving a Motor From a Machine Shop to a Testing Block, Columbus, New Mexico

An increasing number of motor truck companies supported Pershing's force as it moved deep into Mexico. Through August 1, 1916, the Quartermaster Corps had bought 544 trucks, 57 tank trucks, 12 machine shop trucks, and 6 wreckers, and had dispatched most to the border. By the end of 1916, a total of 19

truck trains operated on Pershing's line of communications and two more arrived before the Expedition left Mexico. Between March 17 and July 31, 1916, trucks delivered some 4,272.5 tons of supplies and 638 officers and men to Pershing's force. This was the breakthrough that revolutionized the US Army's transport. Truck transport had proven itself fast, efficient, and economical.⁵ "The development of the motor truck," Secretary of War Newton D. Baker recognized, "has produced a vehicle which is able to traverse wild, unbroken country and, except under abnormal conditions, to transport soldiers and their supplies with certainty and rapidity."⁶

The US Army bureaus enthusiastically accepted the truck. The Quartermaster Corps was especially pleased with its experience in Mexico. Lieutenant Colonel Chauncey B. Baker, in the Office of the Quartermaster General, enthused that the truck was "without question, far more effective than was anticipated by even its warmest advocates."⁷ And in his final report on the Expedition, Major John F. Madden, the quartermaster at Columbus, advocated permanent truck companies equipped with standardized vehicles manned by soldiers trained specifically for this duty.⁸

Other bureaus not only accepted the truck, but each demanded its own organic equipment, a situation that foreshadowed the problem that would become so evident in France months later. The Corps of Engineers found truck companies loaned by the Quartermaster Corps invaluable in its construction efforts. As a result, Lieutenant Colonel Meriwether L. Walker concluded that motor truck transport was absolutely vital. But, he believed, the Engineers must have their own transport: "In theory the calling on the Quartermaster Department [sic] for all transportation is beautiful," he reported, "but in practice it doesn't work."⁹ The Signal Corps found trucks vital for transporting, laying, and recovering miles of telegraph wire, but with the same proviso. "I entirely recommend," Major Walter L. Clark concluded, "that all telegraph companies be issued motor truck transportation."¹⁰ The

Medical Department organized two motor ambulance companies for service in Mexico, but Colonel James D. Glennan, too, felt that organic transport was the direction to take: "The Medical Department is handicapped," he averred, "by being compelled to go to another department for the necessary motor vehicles which our experience shows we need."¹¹ The Ordnance Department, based on tests conducted at Fort Sill by the Field Artillery Board, joined the other Army bureaus in recognizing the advantages of organic motor transport. Finally, Army aviation officials gained additional appreciation for the value of motor transport. The 1st Aero Squadron's experiences in Mexico, however, showed the need for even more transport than authorized. In late 1916, a General Staff study of US Army aviation concluded that each squadron of 12 aircraft should be equipped with 25 trucks and an equal number of trailers.¹²

Despite such enthusiasm, the US Army failed to develop a comprehensive motor transport policy. While Pershing was deep in Mexico, the Quartermaster Corps began a study of Army requirements and launched a program to develop standard trucks in several sizes. In September 1916, the Army formed a provisional division to test the degree that trucks could replace animals as transport. The test concluded that while escort wagons and pack animals were still important for the direct support for troops in the field, the makeup of Army transport had dramatically and irrevocably changed. When the United States declared war on 6 April 1917, the US Army owned 3,039 trucks, 437 automobiles, 12 tractors, and several hundred motorcycles; however, it had failed to rationalize the administration, operation, and support of its motor transport. The US Army learned much about trucks during the Punitive Expedition and in subsequent tests, but was unable to assess fully the implications of motor transport or to develop its potential.¹³ This delinquency would lead to confusion in France.

Motor transport proved to be a major dilemma for the AEF throughout World War I. Based on its experiences in Mexico,



1st Aero Squadron in Mexico (Signal Corps Number 43 Squadron Transport on Left, JN-3 Aeroplane on Right)

and using many of the same vehicles, the Quartermaster Corps organized and sent four truck companies and one "motor park" company for maintenance and repair to France. These arrived at St. Nazaire on 27 June 1917 and provided the nucleus for the AEF motor transport system. Initially, the Chief Quartermaster on Pershing's staff was responsible for the operation and maintenance of the AEF's motor transport, but he had other pressing duties and, while not neglected, motor transport certainly failed to receive the high level of attention required. Further, although the Quartermaster Corps was responsible for transportation, enough leeway existed for other parties to complicate matters. As discussed above, the various Army bureaus had learned the lessons of the Punitive Expedition too well. Organizations within the AEF, including the Ordnance Department, Medical Department, Corps of Engineers, and Air Service,¹⁴ fielded their own fleets of vehicles without coordination and often in direct competition with each other.¹⁵

A worldwide shortage of vehicles compounded the situation. The thirst of the Allied armies for truck transport absorbed European production and tied up a significant portion of American production.¹⁶ The US Army brought thousands of trucks to France, but the American truck industry could not produce enough to meet all needs, and the AEF had to purchase thousands of additional vehicles in Europe, many of them already used. Apparently, the majority of vehicles bought in Europe were well worn before they fell into American hands. And the variety was staggering. As of December 1918, AEF records listed 92 different US and 72 foreign trucks and ambulances, although some of these were one-of-a-kind test vehicles.¹⁷

Further complicating the motor transport equation, AEF authorities initially failed to realize the need to control the operation of the trucks they did have and undervalued the importance of maintenance and supply.¹⁸ "It was assumed," Lieutenant Colonel Gordon R. Young of Pershing's staff later summarized, "that operation was merely a question of driving vehicles; that no particular problems existed in this line; and that operation, repair, and the supply of spare parts did not bear so close a relation to each other as to require centralized control."¹⁹

In this uncoordinated milieu, the AEF's Air Service flourished. Its leaders believed that the flying squadrons required their own organic transport to ensure mobility; permanent depots and training fields required trucks for internal use; and parts, supplies, and equipment had to be moved between units spread across France, many located some distance from the nearest railroad. In July 1917, the Aeronautical Division placed large orders for trucks and other vehicles. Initially, the War Department deferred these orders pending a study to develop specifications for standard US Army trucks. The Aeronautical Division successfully protested, however, and these were the first major orders placed by the Army with US truck firms. A few of the first squadrons to reach Europe brought their organic transport, although they did not always get to keep it. When the venerable 1st Aero Squadron reached France on 1 September 1917, for example, the squadron's trucks were detached immediately and sent to the flying training field under construction at Issoudun. Most vehicles purchased in the United States were shipped independent of the service squadrons. To supplement purchases in the United States, the Air Service

bought a wide variety of new and used trucks overseas. Its main coup was a contract with Italy's Fiat, the largest producer of trucks in Europe.²⁰



Officers and Men of the 360th Aero Squadron With FWD Truck and Trailer, France, 1918

Operationally, the Air Service distributed its motor transport in three general areas. First, supply depots, maintenance depots, and training fields such as Issoudun had permanent vehicle fleets for internal use. These facilities existed in a stable environment and most had their own maintenance capabilities. Second, the Air Service had to deliver supplies and equipment to numerous, widely-dispersed flying fields. Some of these were serviced by truck from nearby railheads, and Air Service officials also established a regular system of convoys that circulated from the depots to the fields once or twice each week, distributing spare parts and supplies. Finally, the air parks and flying fields required some organic transport for jobs such as salvaging downed aircraft. But the Air Service went further. In theory, each flying squadron was supposed to be able to move its aircraft, personnel, and infrastructure on a moment's notice to support the ground forces. While the static nature of warfare on the Western Front had significantly reduced the need for such mobility, the Air Service maintained its prewar commitment to mobile flying squadrons and attempted, with considerable success, to ensure that each had a full complement of vehicles at all times.²¹ By May, the Air Service had largely met its immediate needs for truck transport and had begun gathering a reserve at Romorantin to equip the new squadrons to be formed over the next few months. As of 30 June 1918, the Air Service had 244 heavy trucks and 195 light trucks in its possession.²²

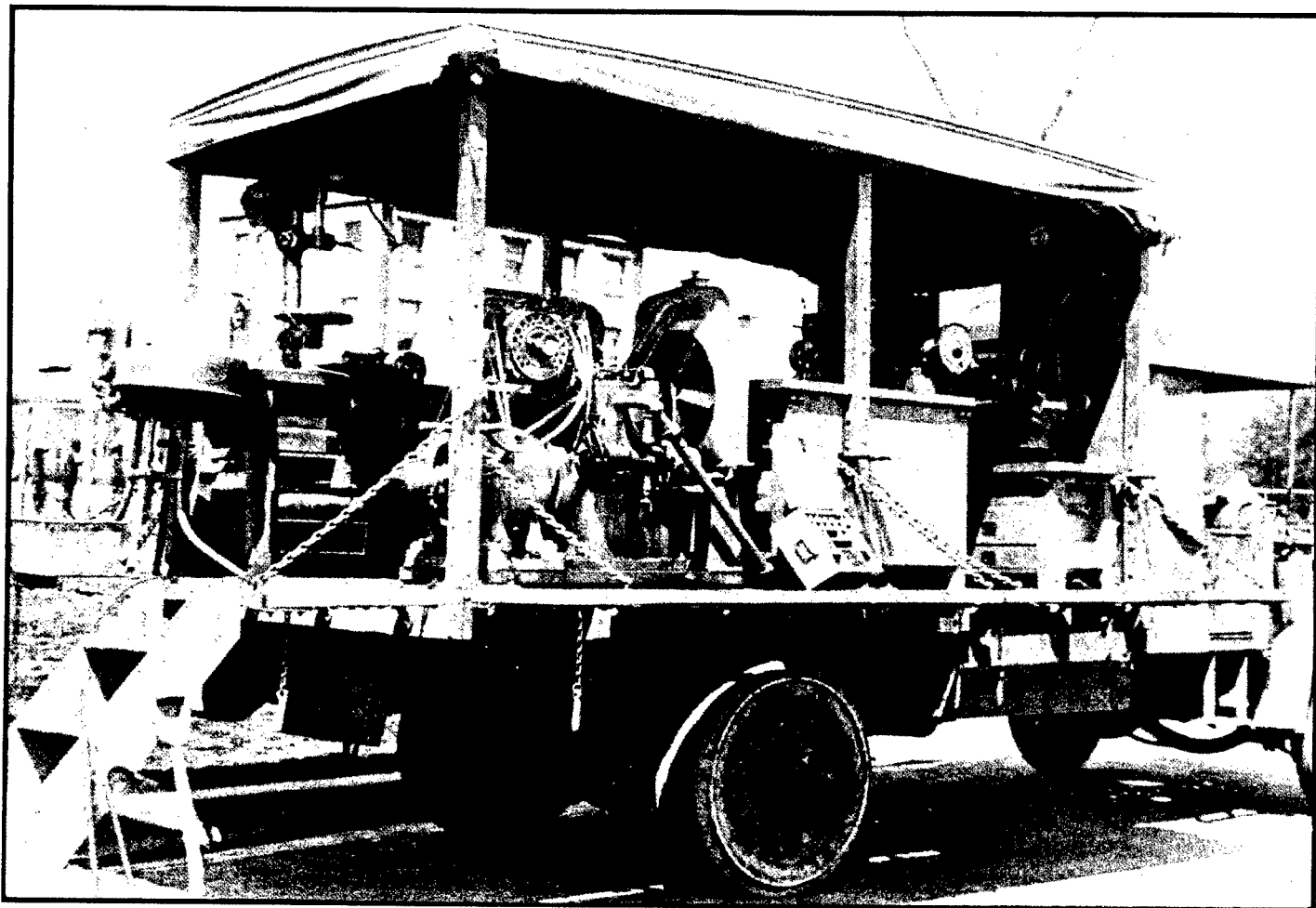
Supporting this vehicle fleet was a difficult matter. The lack of standardized trucks made supply and maintenance a nightmare. So many truck types made the homogenous grouping of vehicles almost impossible. This problem was compounded by the need to push the available vehicles to their limits and the shortage of skilled mechanics. Air Service maintenance personnel scrounged for parts wherever they could be found; wrecked trucks were cannibalized to keep others going, and, when all else failed, mechanics turned to the ever resourceful machine shops to manufacture what was needed.²³ Additionally, the Air Service also established a major repair and supply depot

for truck transport at Romorantin, colocating it with one of the AEF's major aviation depots, Air Production Plant Number 2, and a second truck repair depot at Dijon. By May 1918, AEF officials considered the truck depot at Romorantin to be one of the finest transportation park and repair facilities in Europe.²⁴ Despite the Air Service's best efforts, however, proper truck maintenance proved elusive. Individual aviation units provided most basic vehicle maintenance, and quality varied widely from unit to unit. An inspection shortly before the end of the war found transport at "a few stations excellent, in many fair, in some inefficient, and in a few deplorable." Overall, the inspectors concluded, motor transport was badly cared for and the transport branch of the Air Service lacked "discipline, good morale, and pride in the condition of the vehicles."²⁵

In the meantime, the dramatic expansion of the US Army in France forced changes in the administration of the AEF's motor transport. Leaving it in the hands of several different bureaus was manifestly wasteful. The Ordnance Department, for example, bought several hundred trucks designed specifically to carry shells and ammunition, but useless for any other purpose. And the Air Service and Ordnance were the only bureaus that planned and organized for maintenance and repair; the Medical Department, in contrast, brought hundreds of ambulances, but made no provision for support of any kind. The supply and maintenance requirements for the independent fleets of vehicles

proved both inefficient and wasteful, and standard training for drivers and mechanics, vital for efficiency, was out of the question. Additionally, the various bureaus bidding against each other for the few vehicles available, accomplished little more than to make several European dealers richer. The problem became most critical in early 1918 when the shortage of trucks and their uneven distribution across the AEF began affecting support of the big American infantry divisions, a development Pershing refused to tolerate.²⁶

Pershing took the first step toward correcting the problem on 8 December 1917 when he established the Motor Transport Service of the Quartermaster Corps, centralizing all aspects of motor transport *except operations* within one office under the Chief Quartermaster. Subsequently, as part of the radical revision of the AEF's supply system, Pershing created the Service of Utilities as a branch of the Service of Supply on 16 February 1918 and placed the Motor Transport Service under the new organization. This step apparently had the effect of giving the Motor Transport Service somewhat greater independence as an established section in a newly created entity, but still failed to address the fundamental problems of motor transport in the AEF. Especially, the exponential growth in the AEF's motor transport justified creation of an independent administrative organization. Further, while the question of centralized operational control of the motor transport belonging to the field armies remained in



Signal Corps Machine Shop Truck, April 1918

question throughout the war, it was manifest that centralized control of that portion assigned to the Service of Supply would be more efficient.²⁷

Another curiosity was that the 16 February general order gave the Motor Transport Service responsibility for all motor transport except that belonging to the Air Service. The reasons for the Air Service being excepted from central control for the time being are open to speculation. The uniqueness of the air arm, for one, and the fact that British aviation maintained independent motor transport, for another, were undoubtedly factors. At any rate, the Air Service exemption did not last for long. AEF officials criticized the goal of making every squadron mobile. Most squadrons moved infrequently, they stated, and, in the meantime, squadron-level transport was surplus. Further, the reserve being assembled at Romorantin failed to go unnoticed. Three additional measures addressed these conditions and unified the AEF's motor transport system. On 11 May, Pershing established the Motor Transport Service as a separate organization with representatives on the principle staffs of the AEF, and ordered the Air Service to relinquish to it its vehicles. Further, beginning on 20 May, all trucks arriving from the United States were delivered directly to the Motor Transport Service, including those purchased and shipped by the Aeronautical Division. Finally, the Motor Transport Service was removed from the Service of Utilities, becoming the Motor Transport Corps under the Service of Supply on 11 July 1918. From July to the end of the war, the only element of motor transport that remained outside of Motor Transport Corps control was that assigned to combat organizations. Subsequently, Pershing, at the insistence of the Allied High Command, agreed to place all American motor transport under the Motor Transport Corps in general conformity to French practice, but the war ended before this plan was implemented.²⁸

Under the July organization, the Motor Transport Corps took charge of the Air Service's motor transport at the flying fields, training fields, and depots, as well as the reserve transport at Romorantin. Where absolutely necessary, the Motor Transport Corps left the transport in the possession of the unit, but anything else became excess and was turned in. The Air Service managed only those vehicles allotted by the Motor Transport Corps to its flying squadrons, flying fields, depots, and the few spare parts convoys. The vehicle repair facility at Romorantin sparked a major controversy because it was closely associated with the airplane repair operation at that location. However, by the end of the war, the Motor Transport Corps managed all major repair work including that at Romorantin, while the Air Service remained responsible for minor repairs. Under this arrangement, the Air Service kept its squadron-level mobile machine shop trucks.²⁹

After 11 May, Air Service units obtained motor transport by submitting requisitions to the Air Service Supply Section, which consolidated the requests and forwarded them through the AEF's General Headquarters to the Motor Transport Corps. The Motor Transport Corps primarily issued motor transport on the basis of table of organization that had been compiled without input from any central authority and were often wide of the mark as to what was actually required. The requisitions from the Air Service were given a priority and transport issued accordingly,

but since vehicles were always in short supply, requesting organizations often received a fraction of what they required, or nothing at all.³⁰

Air Service leaders were displeased with what they considered an inflexible, unresponsive system. It proved impossible to shift transportation from the schools to the front or vice-versa as rapidly as needed, and vehicles turned in to the Motor Transport Corps were often never seen again. An officer in the Air Service's Transportation Division claimed that the Motor Transport Corps grew so unwieldy that Air Service requisitions were lost in a deluge of demands. Further, he asserted that in a few weeks the new arrangement had destroyed the Air Service plan to standardize aviation vehicles and spare parts. Another officer later estimated that, under the Motor Transport Corps, the Air Service had the use of only 50% of the transportation that it had brought to France. And Captain J. Stanford Edwards of the Transportation Division pointed out that both the French and British had found independent transport for their air forces to be a necessity, and cited the special challenges of a new combatant arm grappling with a revolutionary weapon as justification for a separate system special to the Air Service.³¹ In this view, he echoed the flamboyant airpower advocate Colonel William "Billy" Mitchell, commanding the air units assigned to the US 1st Army in July 1918, who declared that in

a service which has to change its methods, equipment, and ways of working almost daily, such as the Air Service, great elasticity must be permitted; and on account of the distance encountered between elements of the air service itself and the rapid moves which have to be made from one field of operations to another, a relatively large amount of transportation has to be kept constantly on hand.³²

The flying squadrons felt the pinch, but most units adjusted. The 2nd Day Bombardment Group, for example, pooled the transport assigned to its squadrons achieving both economy and flexibility in the process,³³ and the 1st Pursuit Group, to the same effect, centralized operations and maintenance of its squadron transport under the air park that provided the group's logistical support.³⁴ Most post-war recommendations advocated that in the future each squadron have a full complement of transport. Captain Charles L. Heater, commander of the 11th Aero Squadron, reported that his unit never had the transport it required and this "hampered operations to a great extent."³⁵ Captain Harry T. Wood of the 1st Observation Group opined that: "The ideal squadron would be one with sufficient transportation to move bag and baggage at a moment's notice and one which could draw its own supplies."³⁶ Squadron supply officers—including those of the I Corps Observation Group, the 12th Aero Squadron, and the 50th Aero Squadron—expressed deep frustration over the difficulty obtaining motor transport when it was required.³⁷

In retrospect, the reaction of Air Service officers to the Motor Transport Corps was short-sighted and selfish. The AEF was desperately short of motor transport throughout the war. Major General James G. Harbord, head of the Services of Supply, noted that in August 1918 his organization, the lifeline of the AEF, had only half the trucks and automobiles required, and at the Armistice, the AEF as a whole was short some 55,000 vehicles.³⁸ Further, the Motor Transport Corps operated with only 26,000 of the 52,000 personnel it required, and suffered severely for lack of trained drivers and

mechanics.³⁹ Untrained personnel increased the damage to vehicles and drastically increased the burden on maintenance and supply. In a synergistic effect, the fewer vehicles on the road increased demand on those that remained operational, causing these to wear out or break down more quickly. Pershing would have been derelict had he allowed one branch of his army to protect its vehicles while the rest, especially the combat divisions, went short. The centralized system established under the Motor Transport Corps may have handicapped the Air Service, but it enabled the AEF to make the best use of a scarce yet vital resource. The Air Service simply had to suffer along with the rest of the AEF. After an inspection trip to France near the end of the war, Colonel Henry H. Arnold, the future Chief of Staff of the US Army Air Forces during World War II, took a less parochial view of the situation than his contemporaries, accepting that "the needs of the mobile Army were so great that it was given priority for motor transport over the Air Service."⁴⁰

The results of a post-war study by the Air Service's Transportation Division stood in deep contrast to the visceral response of Air Service leaders operating in the pressure cooker of war. The 1919 study concluded that procurement, purchase, overhaul, repair, and all other activities except the "actual assignment and control after the vehicles have been received in the Air Service" should be centralized under a separate organization such as the Motor Transport Corps. Such a system, the study affirmed, would be economical and would be more capable of managing the movement of vehicles, especially overseas. Most important, it would free the Air Service to concentrate on its central mission, airpower. A Motor Transport Corps type organization, the study summarized,

as proven in practice is a splendid one, capable in every way of meeting the demands placed upon it by the various services of the Army and is the logical organization to handle all transportation for the future Army. That it did not realize in this war all that was expected of it, was due to the short time it had to prove its value, and not to anything else.⁴¹

The Air Service thus belatedly recognized that the limits of organic transportation had been reached.

Notes

- See Roger G. Miller, "Wings and Wheels: The 1st Aero Squadron, Truck Transport, and the Punitive Expedition of 1916," *Air Power History* (Winter 1995), pp. 12-29, for a detailed study of that evolution. James M. Laux, "Trucks in the West During the First World War," *Journal of Transport History* (Sep 85), pp. 64-70, provides an excellent survey of the advent and use of truck transport on the Western Front. For data on and photographs of trucks purchased by the US Army during the period see Bart H. Vanderveen, ed., *The Observer's Army Vehicles Directory to 1940* (New York: Frederick Warne & Co., Inc., 1972), and Fred Crismon, *U.S. Military Wheeled Vehicles* (Sarasota, FL: Crestline Publishing, 1983). Norman M. Cary, Jr., "The Use of the Motor Vehicle in the United States Army, 1899-1939," (Unpublished PhD dissertation, University of Georgia, 1980), provides a general history of the development of US Army truck transport prior to World War II, while John C. Speedy III does the same for vehicle maintenance in "From Mules to Motors: Development of Doctrine for Motor Vehicle Maintenance by the United States Army" (Unpublished PhD dissertation, Duke University, 1977).
- Miller, "Wings and Wheels," p. 16.
- Ibid.*, pp. 16-19.
- Ibid.*, pp. 19-20.
- Ibid.*, p. 23.
- Newton D. Baker, "Report of the Secretary of War," 20 Nov 16, *War Department Annual Reports, 1916*, 3 vols. (Washington, DC: Government Printing Office, 1916), I, pp. 22-23.
- Lt Col Chauncey B. Baker, *Motor Transportation for the Army* (Washington, DC: Government Printing Office, 1917), p. 3.
- Miller, "Wings and Wheels," p. 24.
- Lt Col Meriwether L. Walker, Engineer, to Maj Gen John J. Pershing, "Report of Engineer Operations on Punitive Expedition to Mexico from July 1, 1916, to Termination," 5 Feb 17, Box 2020, A.G.O. 370.22, Mexican Punitive Expedition Reports, Record Group (RG) 94, Records of the Office of the Adjutant General, National Archives (NA), Washington, DC.
- Maj Walter L. Clark, Signal Corps, "Final Report of Operations of the Signal Corps Troops With the Punitive Expedition," 7 Feb 17, *ibid.*
- Col James D. Glennan, Medical Corps, "Final Report of Division Surgeon, Punitive Expedition, US Army," n.d., *ibid.*
- Miller, "Wings and Wheels," p. 25.
- Ibid.*; Benedict Crowell, *America's Munitions, 1917-1918* (Washington, DC: Government Printing Office, 1919), p. 501; Brig Gen Henry G. Sharpe, QMG, "Report of the Quartermaster General," 22 Sep 17, *Annual Reports of the War Department, 1917*, 3 vols. (Washington, DC: Government Printing Office, 1917), I, p. 318; Cary, "Use of the Motor Vehicle in the United States Army," pp. 101-105.
- The term "Air Service" was in official use in the AEF by September 1917, but did not apply in the United States until after the War Department removed responsibility for US Army aviation from the Signal Corps in May 1918.
- Rpt, Col C.C. Carson to the Inspector General, GHQ, AEF, Subj: Inspection of Motor Transportation, 28 Apr 18, *Reports of the Commander-in-Chief, A.E.F., Staff Sections and Services, in United States Army in the World War, 1917-1919*, 17 vols. (Washington, DC: U.S. Government Printing Office, 1948), XIV, pp. 277, 279.
- US companies produced 19,360 trucks for the British and another 15,000 for the French. Laux, "Trucks in the West During the First World War," p. 67.
- Rpt, Col C.C. Carson to the Inspector General, GHQ, AEF, Subj: Inspection of Motor Transportation, 28 Apr 18, *Reports of the Commander-in-Chief, A.E.F., Staff Sections and Services*, XIV, p. 282.
- Rpt, Lt Col Gordon R. Young, G-4-D, GHQ, 23 Dec 18, *ibid.*, p. 150.
- Ibid.*
- Memo, Capt G. B. Waterman and Capt George E. Sweet, Transport Division, to Col Dunwoody, 14 Feb 19, pp. 1-2, in "Notes on Supply," Book I, Box 3; Memo, Maj Birdseye B. Lewis, Matériel Dept., to A.C.A.S., 25 Sep 17, Atch to Supply Section Questionnaire, 4 Jan 19, Box 4; and Ltr, Maj John M. Satterfield, Asst Chief, Supply Sec., to C.A.S., AEF, Subj: Discussion of Supply System, 15 Dec 18, Box 4, in Papers of Col Halsey Dunwoody, 11 boxes (Air Force Historical Research Agency, Maxwell, AFB AL), hereafter cited as AFHRA; Ltr, Col H. H. Arnold, Asst Dir., Military Aeronautics, to Dir., Military Aeronautics, Subj: Report on Tour of Inspection of Air Service, A.E.F., 28 Dec 18, H. H. Arnold Papers, 167.607-1, AFHRA. Statement by Col B. D. Foulois, 9 Jul 23, File GR&P 1-F "Things to be Avoided in Procurement," 1923, Box 36, Benjamin D. Foulois Papers, Library of Congress. Fiat produced an estimated 45,650 trucks for the Allied armies during World War I, more than were produced by all German firms for the German army. Laux, "Trucks in the West During the First World War," p. 69.
- Memo, Capt G. B. Waterman and Capt George E. Sweet, Transp. Div., to Col Dunwoody, 14 Feb 19, p. 9, in "Notes on Supply," Book I, Box 3, Dunwoody Papers, AFHRA; Rpt, Lt Col Gordon R. Young, G-4-D, GHQ, 23 Dec 18, *Reports of the Commander-in-Chief, A.E.F., Staff Sections and Services*, XIV, p. 157.
- Rpt, Subj: "The Transportation Division," n.d., Series A, Vol. 16, Roll #4, and Rpt, "Transportation Section as of June 30, 1918," p. 19, Series A, Vol. 4, Roll #2, Microcopy No. 619, "Col Gorrell's History of the US Army Air Service," The National Archives and Records Service, Washington, DC, hereafter cited as Gorrell.
- Memo, Capt G. B. Waterman and Capt George E. Sweet, Transp. Div., to Col Dunwoody, 14 Feb 19, pp. 3, 10, in "Notes on Supply," Book I, Box 3, Dunwoody Papers, AFHRA.
- Rpt, Subj: "The Transportation Division," n.d., Gorrell, Series A, Vol. 16, Roll #4, and Rpt, "Transportation Section as of June 30, 1918," p.

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25. Lt Col Warwick Greene, Chief, Executive Section, Air Service, AEF, in Maurer, ed., *U.S. Air Service in World War I*, 4 vols. (Washington, DC: The Office of Air Force History, 1978), IV, pp. 213-14.
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28. Rpt, Brig Gen George Van Horne Moseley, Asst Chief of Staff, G-4, GHQ, 5 Apr 20; Rpt, Lt Col Gordon R. Young, G-4-D, GHQ, 23 Dec 18, *Reports of the Commander-in-Chief, A.E.F., Staff Sections and Services*, XIV, pp. 64-65, 151, 159; Memo, Capt G. B. Waterman and Capt George E. Sweet, Transp. Div., to Col Dunwoody, 14 Feb 19, p. 8, in "Notes on Supply," Book I, Box 3, Dunwoody Papers, AFHRA. Corresponding changes in the organization of motor transport in the United States took place at later dates than in the AEF, leading to the Motor Transport Corps as a separate corps on 15 Aug 18. Rpt, Lt Col Gordon R. Young, G-4-D, GHQ, 23 Dec 18, *Reports of the Commander-in-Chief, A.E.F., Staff Sections and Services*, XIV, p. 152.
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31. Ltr, Maj John M. Satterfield, Asst Chief, Supply Section, to C.A.S., AEF, Subj: Discussion of Supply System, 15 Dec 18, Box 4, and Memo, Capt J. Stanford Edwards, Chief, Transportation Division, Air Service AEF, to Col Dunwoody, 24 May 19, pp. 2-3, Box 3, Dunwoody Papers, AFHRA; Rpt, Subj: The Transportation Division, n.d., Gorrell, Series A, Vol. 16, Roll #4; H. A. Toulmin, Jr., *Air Service, American Expeditionary Force, 1918* (New York: D. Van Nostrand Company, 1927), p. 31.
32. Memo, Col William Mitchell, Cmd., 1st Brigade, Air Service, to Chief of Air Service, 1st Army, 9 Jul 18, quoted in Brig Gen William Mitchell, *Memories of World War I: From Start to Finish of Our Greatest War* (New York: Random House, 1960), p. 217.
33. Rpt, Maj George E. A. Reinburg, Cmd., 2nd Day Bombardment Group, to Air Service Cmdr., 2nd Army, 19 Dec 18, Gorrell, Series A, Vol. 15, Roll #4.
34. Memo, Capt G. B. Waterman and Capt George E. Sweet, Transp. Div., to Col Dunwoody, 14 Feb 19, pp. 2-3, in "Notes on Supply," Book I, Box 3, Dunwoody Papers, AFHRA; "Tactical History of Pursuit Aviation," in Maurer, *U.S. Air Service*, I, p. 298.
35. Capt Charles L. Heater, C.O., 11th Aero Squadron, in Maurer, *U.S. Air Service in World War I*, IV, p. 96.
36. Capt Harry T. Wood, C.O., 1st Army Observation Group, *ibid.*, IV, p. 97.
37. See the comments by Lts Andrew Anderson, A. M. Wright, and O. D. Burwell in *ibid.*, IV, pp. 272-73, 276.
38. Maj Gen James G. Harbord, *The American Army in France, 1917-1919* (Boston: Little, Brown, and Co., 1936), p. 369.
39. Rpt, Col C. C. Carson to The Inspector General, GHQ, AEF, Subj: Inspection of Motor Transportation, 28 Apr 19, *United States Army in the World War*, XIV, p. 280.
40. Ltr, Col H. H. Arnold, Asst Dir., Military Aeronautics, to Dir., Military Aeronautics, Subj: Report on Tour of Inspection of Air Service, AEF, 28 Dec 18, H. H. Arnold Papers, 167.607-1, AFHRA.
41. Memo, Capt J. Stanford Edwards, Chief, Transp. Div., Air Service, AEF, to Col Dunwoody, 24 May 19, p. 6, Box 3, Dunwoody Papers, AFHRA.

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(Continued from page 18)

Cargo Data Collection Architecture, Analysis, and Reporting, LT9604600

Objectives: (1) Devise a data collection and reporting tool for transportation movement data to include origin pickup and delivery at destination from airlift and express carriers. (2) Develop an automated process to collect and process the data to provide standardized and ad hoc reports and analysis. (3) Develop the product(s) to produce standardized and ad hoc reports and analysis from the data. (4) Evaluate long term viability of the system to include proposed architecture and

ownership. (5) Provide Air Force decision makers with a tool to collect, process, and analyze transportation movement data allowing for standard and ad hoc reports and analysis.

Capt Michael B. McDaniel, AFLMA/LGT, DSN 596-5803

Automating Vehicle Equivalent Methodology, LT9607300

Objective: Automate the vehicle equivalent algorithm from AFLMA Project LT912103.

Capt Michael T. Conley, AFLMA/LGT, DSN 596-4165

(Continued from page 33)

reinforcing in the next generation of senior leaders, the absolute criticality of logistics support to any successful military operation. Strategic logistics revealed itself to be as much art as science.

John Auger is an on-site support manager for Science Applications International Corporation (SAIC) at the Army War College in Carlisle, Pennsylvania. 

Most Significant Article Award

The Editorial Advisory Board has selected "Applying Neural Networks to Demand Forecasting," written by Captains Mark A. Abramson, USAF, and Harry A. Berry, USAF, as the most significant article in the Summer-Fall 1996 issue of the *Air Force Journal of Logistics*.

