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LOGISTICAL EFFECTIVENESS OF TWO-LEVEL MAINTENANCE

by

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Preface

In the past 10 years, the logistics community has absorbed an incredible amount of change. Two-Level Maintenance was heralded as the means of significantly reducing the logistical tail without impacting mission readiness. Analyzing the lessons from Operation ALLIED FORCE will help us reach a better understanding of its impact on our combat capability.

This research would not have been possible without the help, support, and encouragement of several people. First and foremost, my wife, Alma, and my children (Jan Carlos, Yashera, and Justin) were my key inspiration. They encouraged and supported me through many long nights of research. I owe them my deepest gratitude.

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A big thanks to Master Sergeant Bill Daniels from the 20th Logistics Group at Shaw AFB who provided his expertise on the Gold Flag program. His contributions will hopefully enable higher mission readiness through base self-sufficiency.

Finally, I want to thank Major Dave Smith, my faculty research advisor, for his support during this endeavor. By allowing me to run with the ball, I was able to reach higher levels in this research project.

Abstract

The Secretary of Defense tasked the Air Force to reduce its mobility footprint in support of contingency operations. Reduced budgets, force structure, equipment, and infrastructure forced the Air Force to reevaluate its logistical structure. Specifically, the logistics community had to find a better way to move thousands of personnel and equipment to support our expeditionary aerospace forces.

The result of these efforts was a new concept in logistical support. Lean Logistics and its principal concept, Two-Level Maintenance (TLM), sought to shrink the mobility footprint by drastically reducing base intermediate-level repair and establishing a leaner two-level repair process. TLM promised to reduce the logistical infrastructure, produce significant savings and manpower costs, and increase survivability during contingency operations.

A closer analysis of TLM shows that it did not achieve the full measure of the intended benefits. The projected net savings for implementing TLM did not materialize because of unexpected cost overruns. Transferring the repair of avionics boxes and engines from base level to depot level resulted in a bottleneck of 5,575 critical parts in the depot repair system. Audits conducted by federal and military audit agencies observed a sharp increase in aircraft cannibalizations following TLM implementation and a steady decline in mission capable rates.

This paper will analyze in detail the impact of TLM, its impact during Operation ALLIED FORCE, and propose some recommendations that will hopefully improve this key logistical process.

Part 1

Evolution of Aircraft Maintenance Logistics

This is not a war of ammunition, tanks, guns, and trucks alone. It is as much as a war of replenishing spare parts to keep them in combat as it is a war of major equipment.

— Ernie Pyle, Newspaper Correspondent

Introduction

Logistics as a whole saw an incredible transformation after the Persian Gulf War. Although Operation DESERT STORM validated our logistical capability, it highlighted the size of our logistical footprint in terms of equipment and personnel required to accomplish the mission. In the aftermath of this conflict, the Air Force realized that it had to find the means of shrinking this logistical tail. Two-Level Maintenance (TLM) was one of the key initiatives under the Air Force's "Lean Logistics" concept that reduced intermediate maintenance at base level and significantly curtailed mobility requirements for contingency operations.

In the past seven years, we have seen a significant decline in the Combat Air Forces' mission capability rates (figure 1). Many factors have contributed to this steady decline. Budget reductions, increased operational tempo, and lower enlisted retention rates have all contributed to this decline. The decline in mission capability also raises some questions relating to the drastic and far reaching measures that were taken with the implementation of TLM. Although TLM appeared to be a sound solution for the Global Reach-Global Power strategic vision of the early

1990s, the reality has set in at the beginning of the 21st century that our logistics system is struggling to meet operational needs for the new Global Engagement strategic vision. To better understand these drastic changes implemented with TLM, it is important to first discuss the evolution of aircraft maintenance concepts that preceded the advent of Lean Logistics and TLM.

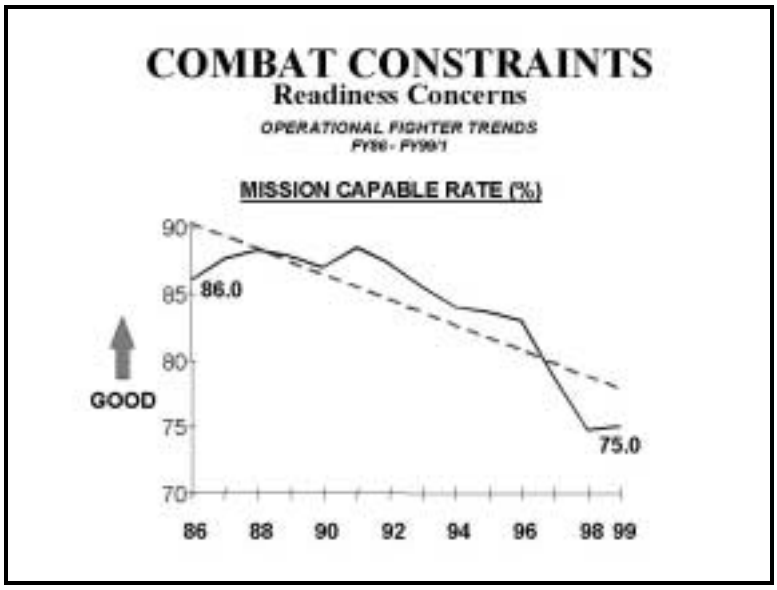

Figure 1. Combat Air Forces' Mission Capable Rates[1]

Historical Evolution

The Air Force began testing different approaches to aircraft maintenance back in the Vietnam War. Studies conducted during this period showed that some improvements in mission readiness were achieved with centralized maintenance, but were not fully implemented due to deficiencies in command and control structures.[2] The Maintenance Posture Improvement Program (MPIP) was a series of studies conducted during the mid-1970s that analyzed alternative aircraft maintenance structures. The Pacific Air Command (PACAF) at bases in Korea, Japan, and the Philippines mainly conducted these studies. During the MPIP, each maintenance activity was examined for potential cost savings, mission capabilities, and reduced

vulnerability. The program sought to identify strategies that would achieve improved mission capabilities while simultaneously reducing cost.

Centralized Intermediate Repair Concept

The main concept studied under MPIP was the Centralized Intermediate Repair Concept (CIRL). This concept had two main elements: (1) the Centralized Intermediate Repair Facility (CIRF), which repaired avionics, engines, and performed limited field maintenance, and (2) the Forward Operating Locations (FOLs), which would perform flightline-only maintenance. During the course of these studies, analysts noted improvements in mobility, increased sortie production, improved survivability, and enhanced resource management.[3]

An additional benefit of CIRL was that assembly line production methods enhanced the quality of the maintenance being performed. The increase time between maintenance actions for CIRF items resulted in a 42 percent reduction in man-hours by the FOLs per sortie.[4] Basically, the CIRF allowed maintenance personnel to devote more time and attention to on-equipment actions such as delayed discrepancies. The added emphasis on flightline maintenance resulted in higher sortie generation capability.[5]

Although the studies validated the efficiency of regional repair facilities, the concept was abolished in 1987, since PACAF felt that regional repair facilities would be too vulnerable during an enemy attack.[6] Facilities at Kadena were decentralized since PACAF believed that repair facilities would be more survivable if there were scattered rather than centralized at one or two locations. These efforts for innovation vanished and opened the way for the more traditional means of aircraft maintenance.

Three-level Maintenance

Three-level Maintenance (3LM) was the conventional means of performing aircraft maintenance. Shortly after its inception in 1947, the Air Force developed a maintenance production program consisting of three-levels: organizational, intermediate, and depot level maintenance. Organizational-level maintenance included flightline maintenance performed at each operational wing, such as removing and replacing LRUs (line-replaceable unit) and accomplishing minor repairs on the weapon system.[7] When a malfunction was observed in a system, flightline personnel would attempt to correct the problem through alignment, adjustment, or minor repair on the aircraft. Usually, defective LRUs would be removed from the aircraft and replaced with a serviceable unit. The reparable component (suspected of being defective) would then be delivered to an intermediate-level repair shop on the base.

Intermediate-level maintenance tasks included performing tests on LRUs, and accomplishing needed repairs through removal and replacement of faulty components called SRUs (shop-replaceable unit). Back-shop technicians would conduct fault isolation procedures with test benches to identify a faulty circuit card or component. If the repair of the LRU was beyond the capability of the AIS (avionics intermediate shop), the reparable asset was declared NRTS (not repairable this station) and shipped to the depot. Under 3LM, depot-level maintenance consisted of component repairs beyond the capability of the base intermediate-level shops and included the overhaul of LRUs and SRUs.

General Issue

TLM significantly reduced base intermediate-level repair capability, an essential element of combat support for expeditionary aerospace forces. The plan to airlift defective parts from the

Area of Responsibility (AOR) back to CONUS in lieu of deploying intermediate-level equipment and personnel created a new airlift burden and degraded combat sustainability.

Research Question

Can the current TLM system adequately respond and sustain the needs of our global expeditionary force? What other alternatives or options exist to improve the TLM structure?

Limitations of the Research

Much of the data collected from the recent Air War over Serbia was either unedited or undergoing classification. The Air Force Historical Research Agency was the sole source for information on AWOS, and it was only available in draft form.

Summary

This chapter reviewed the historical origins of Centralized Intermediate Maintenance and 3LM. Centralized Intermediate Repair Concept was used as early as the Vietnam War, but the concept remained dormant until its re-mergence during the air campaign in Kosovo. Logistics as a whole evolved from a robust 3LM concept to an TLM concept that included significant reductions in base-level manning and equipment, and ultimately impacted the execution of the Air War over Serbia.

Notes

1. House, Department of Defense on Readiness: *Hearings before the Subcommittee for Military Personnel and Military Installations on Readiness*, 106th Cong., 1st sess., 1999, 1.
2. Ronald S. Hunt, *An Assessment of Centralized Intermediate Maintenance Upon Combat Capability*, AFIT/GLM/LSM/88S-37 (Wright Patterson AFB, Ohio: AFIT, 1988), 15
3. Ibid.,16.
4. Ibid.,24.
5. Ibid.,25.
6. Ibid.
7. Jackie R. Crawford, Depot Implementation of the Two-Level Maintenance Concept, Project 94062004 (Washington, D.C.: Air Force Audit Agency, 1995), 15.

Part 2

Two-Level Maintenance Program Assessment

Without supplies neither general nor a soldier is good for anything.

— Clearchus of Sparta

Lean Logistics, "Tooth-to Tail"

Two-Level Maintenance Studies

During the military buildup of the 1980s, the Air Force dedicated over one-third of its manpower to aircraft maintenance.[1] As the US prepared to execute DESERT SHIELD/STORM, the military moved more than 550,000 passengers and 500 tons of cargo in support of this operation. As a result of this immense footprint, DoD Directive 947 was issued, tasking the Air Force to examine the feasibility of reducing or eliminating selected levels of maintenance in support of the Global Reach-Global Power concept.[2]

As a result of DOD Directive 947, the Air Force developed the Lean Logistics program designed to promote combat capability, enhance war-fighting sustainability, shrink the logistics footprint, and reduce the infrastructure. Its goal was to:

> Enhance combat capability while reducing the annual operating cost of Air Force systems by adopting state-of-the-art business practices and streamlined processes, and by reducing infrastructure throughout the Air Force logistics community.[3]

The purpose of TLM was to save money by reducing maintenance staffing, equipment, and base-level support without sacrificing force readiness. To accomplish this, the number of

maintenance levels was reduced from three (organizational, intermediate, depot) to two (organizational and depot). Maintenance previously performed at the intermediate-level would be performed at the depot level. According to TLM planners, the Air Force would be able to reduce the number of maintenance personnel by 5,888 positions Air Force wide and reduce equipment requirements by 10 percent. The initial cost of the TLM conversion was $1.043 billion and after full implementation it was projected to save $1.428 billion over a 5-year period (1994-1999).[4]

With the assistance of the Research and Development Corporation (RAND), TLM tests were conducted at several Tactical Air Command (now Air Combat Command) bases. The tests--Coronet Deuce, Coral Star, and Coral Thrust—involved F-16 avionics items as well as several engines such as the F100-220, TF33-103, and TF33-7A.[5] One of the critical findings from the RAND study dealt with depot repair cycle pipeline. This finding warned the Air Force that TLM would only work if the depots could improve their responsiveness. The study stated:

> Two levels of maintenance could be the most cost-effective maintenance structure, but only if the depot component repairs system is sufficiently responsive to obviate the need for the much greater investments in spares that would be required with current depot pipeline times. If the depot's performance stays the same, performance would suffer under TLM unless sufficient spares were available to fill the longer pipelines. Thus, the effectiveness of TLM depends heavily on Air Force Logistics Centers' motivation and ability to achieve genuinely relevant, timely, and robust depot-level component repair.[6]

Based on the test results, the Secretary of the Air Force approved the Lean Logistics Concept (figure 2), directed implementation of TLM for every new weapon system, and encouraged this concept for existing systems. On 1 October 1993, the Air Force began the official implementation of TLM for selected engines and avionics equipment.[7]

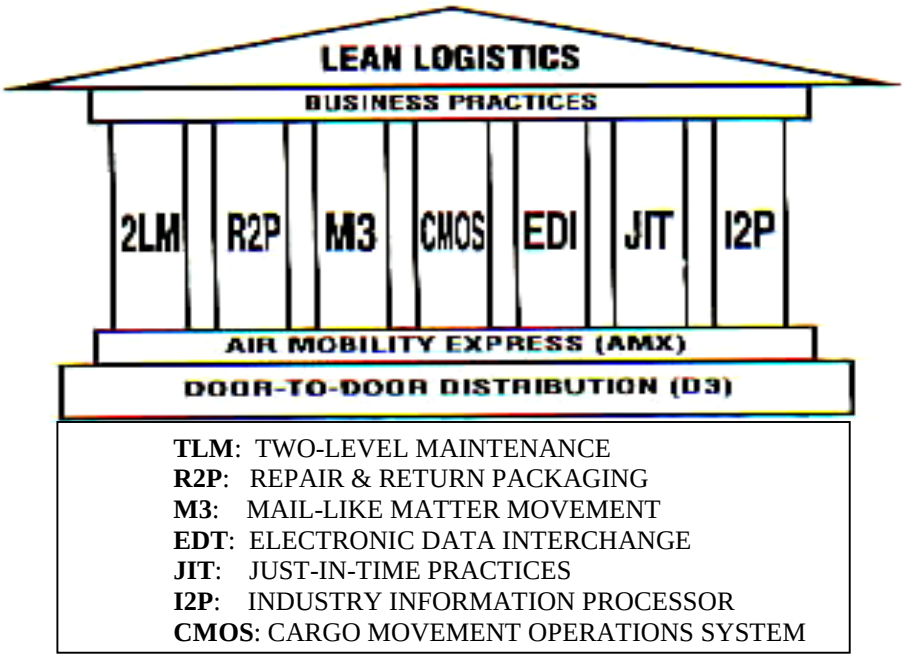

Figure 2 The Lean Logistics Building

Depot Support Under TLM

Sustainability

As RAND highlighted in their initial studies, improving depot performance was paramount to the successful implement of TLM. Two and one half years after implementation, the Air Force Audit Agency (AFAA) conducted a series of audits on the repair cycle pipeline to determine if TLM was in fact improving mission readiness while reducing cost. A May 1996 audit report concluded that AFMC did not meet the expectations for depot-level repair of intermediate-level parts. The report stated:

> AFMC personnel did not repair sufficient quantities to meet requirements for 86 percent of the critical items reviewed. As a result, weapons systems, associated line replacement units, and subassemblies unnecessarily accumulated over 1 million not mission capable (NMC) hours, and had approximately 5,575 outstanding priority backorders. Furthermore, sufficient assets were not available

> to replenish Mission Readiness Spares Packages, and items averaged over 3 years in the Critical Item Program. Consequently, maintenance activities did not have the assets needed to fully perform their mission and maintain systems at full operational readiness.[8]

Earlier advocates of Lean Logistics rebuked critics who were concerned that TLM would increase cannibalization actions to fix aircraft, since the parts would be tied up in the longer repair cycle pipeline. The audits conducted on TLM validated these concerns. Between November 1994 and February 1995, the Air Force accomplished 617 cannibalization actions for 65 items. These actions increased both the maintenance workload and the risk of equipment damage. In fact, the 617 cannibalizations actually represented at least 1,234 maintenance actions because replacing cannibalized items results in a subsequent maintenance action.[9] Figure 3 shows the total cannibalization rates since the inception of TLM

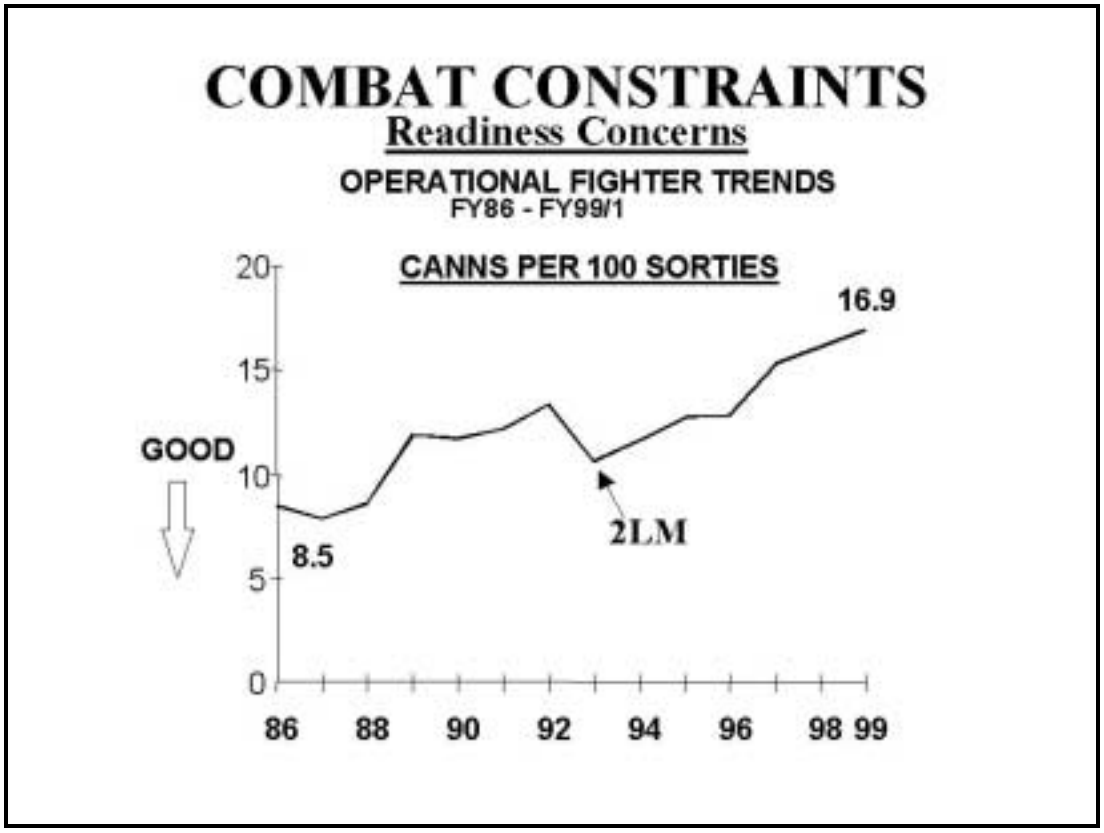

Figure 3 Cannibalization Rates for Combat Forces[10]

As a result of the TLM implementation, the reduction of equipment and personnel deploying to contingencies impacted the mix and number of items needed in readiness spares packages (RSP). A 1995 Air Force Audit report discovered that the depots did not accurately adjust readiness spares package requirements for items transitioning to TLM. The audit stated:

> Item managers did not always adjust time-phased requirement computations, and weapon system product directorates did not remove all items used to support repair of next higher assemblies from appropriate RSP. Weaknesses in the internal control structure associated with the approval and implementation of RSP caused these conditions. As a result, RSP requirements were misstated by at least $61.9 million.[11]

Responsiveness

The Air Force Audit Agency and the General Accounting Office (GAO) conducted audits that highlighted additional areas of concern. The GAO report stated that TLM did not achieve the full spectrum of cost savings. First, TLM was expected to reduce 5,888 (5,770 military and 118 civilians) positions totaling $385 million in savings. Three years after TLM implementation, the Air Force had only reduced 1,171 positions.[12] Further cost savings evaporated as new unplanned costs appeared, such as depot facility upgrades. These and other factors reduced the overall savings from $385 million to $258 million. Additionally, the Air Force removed three engines from the program because the engines were not as reliable as initially thought. Keeping the engines in the program would have resulted in additional transportation costs to move the engines to the depots for frequent repairs.[13]

Critical to the successful implementation of TLM was responsiveness in terms of turn-around times for avionics LRUs and engines inducted into the depot repair facilities. The GAO report discovered that after three years of TLM, the turn-around times for engines had in some instances doubled from the pre-TLM averages. Table 1 summarizes the repair turn-around times for engines under TLM.

Table 1 Engine Repair Turn Around Times[14]

Engines (aircraft)	Pre-TLM Average	Standard	Actual (1996)	Delta +/-
F100-200 (F-15/16)	26.2	19.5	51.0	+ 24.8
T56 (C-130)	57.4	19.5	74.5	+ 17.1
TF39 (C-5)	77.2	71.5	129.5	+ 52.3
TF33-7A (C-141)	89.2	51.0	66.3	- 22.9
TF33-103 (B-52)	94.0	46.0	54.0	- 40.0

Time Definite Resupply

Earlier advocates of Lean Logistics were keenly aware of the inherent weakness of TLM: transportation. The TLM system relies heavily on a robust transportation structure. Currently, parts removed from aircraft are returned to the depot for repair and returned to the unit once repaired.[15] When Air Force units deploy overseas, they no longer have intermediate-maintenance capability with them for their TLM avionics items and engines. Instead, units rely on airlift to transport their unserviceable TLM assets to the depot for repair. Likewise, they rely on airlift for replenishment stocks.

Not deploying the intermediate maintenance capability was supposed to reduce airlift requirements by the equivalent of 173 C-141 missions during the first 30 days.[16] Before TLM, the plan was to airlift the intermediate-maintenance capability to the theater sometime after the initiation of mobilization. TLM, however, required airlift much earlier in the contingency for returning and replenishing spare parts inventories. Because airlift is not dedicated for these purposes, retrograde (parts awaiting repair) and resupply compete with other airlift requirements[17].

Summary

This chapter addressed key deficiencies in the TLM program. First, the Air Force failed to reach the expected savings from reductions in personnel and equipment. It also failed to ensure

the continuos flow of reparables from an operational location to the CONUS depots. A GAO report identified the shortcomings of the repair cycle times for both avionics and engines under TLM. Although TLM presented itself as an attractive solution because of its economies of scale, it degraded combat capability by bottlenecking the repair cycle pipeline and increasing cannibalization actions to maintain required mission capability during contingencies.

Notes

[1.] Maj Scott A. Miller et al., "Unlikely Partners: Two-Level Maintenance and the Air Force Gold Program," *Air Force Logistics Journal* 20, no. 2 (Spring 1996), 1.

[2.] Lt. Col. Ronald Lee, *Two-Level Maintenance, The Way of the Future*, AWC 94-92 (Maxwell AFB, Alabama: Air War College, 1994), 6.

[3.] Colonel Arthur B. Morrill III, "Lean Logistics: Its Time Has Come," *Air Force Logistics Journal* 18, no. 2 (Spring-Summer 1994), 8.

[4.] General Accounting Office, *Report to the Secretary of Defense: Air Force Maintenance, Two-Level Maintenance Program Assessment* (Washington, D.C.: Comptroller General of the United States 1996), 3.

[5.] Ibid.

[6.] John B. Abell and H.L. Shullman, *Evaluations of Alternative Maintenance Structures*, RAND Report R-4205-AF (Santa Monica, Calif.: RAND, August 1992), 14.

[7.] Miller, 2.

[8.] David W. Dennis and Kenneth E. Gregory, *Critical Item Repairs,* Project 95062002 (Washington, D.C.: United States Air Force Audit Agency, 1996), 2.

[9.] Ibid., 2.

[10] House, Department of Defense Readiness: *Hearings before the Subcommittee for Military Personnel and Military Installations on Readiness*, 106th Cong., 1st sess., 1999, 1.

[11.] Dennis, 3.

[12.] General Accounting Office, 3.

[13.] Ibid.

[14.] Ibid., 9.

[15.] Lee, 9.

[16.] Ibid.

[17.] General Accounting Office, 11.

Part 3

The Air War Over Serbia

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

— Ulysses S. Grant

Introduction

The United States and its North Atlantic Treaty Organization (NATO) allies executed Operation ALLIED FORCE from 24 March through 9 June 1999. For 81 days, U.S. and allied aircraft flew more than 38,000 sorties prosecuting the Air War Over Serbia (AWOS).[1] Air Force logisticians in every corner of the European Theater and back in the Continental United States (CONUS) worked around the clock to support this operation. Over 10,000 maintenance personnel supporting 563 aircraft at 25 different locations generated over 11,600 combat sorties that delivered the decisive blow to Slovidan Milosevic and stopped the brutal genocide in Kosovo.[2]

Logistical Effectiveness during AWOS

This section will discuss how TLM impacted the execution of the Air War over Serbia. Although the logistical data captured from AWOS is still raw in many respects, it presents a clear picture of how TLM had detrimental consequences during this contingency.

Mission Readiness

A comparison of the mission capable rates during Operation ALLIED FORCE and Operation DESERT STORM reveal a significant reduction in mission readiness (Table 2). There are many factors that contributed to this decline. Age of the equipment and the aircraft involved in ALLIED FORCE is one factor that contributed to lower mission capability (MC) rates. Many of the aircraft deployed to ALLIED FORCE saw similar action nine years earlier during DESERT STORM. A significant contributor to the decline in mission readiness can be also attributed to smaller MRSP kits and the longer logistical tail for the repair cycle. These changes in conjunction with TLM can perhaps explain how the percentage of aircraft non-mission capable for supply increased from 5.5 percent during DESERT STORM to 10.4 percent during Operation ALLIED FORCE.[3]

Table 2. Aircraft Mission Capable Rates[4]

Aircraft	Mission Capable Rate Operation ALLIED FORCE	Mission Capable Rate DESERT STORM	Delta +/-
A-10	73.5	89.1	- 15.6
F-16 (all models)	78.3	85.3	- 7.0
U-2	58.2	82.5	-24.3
F-15E	75.6	90.0	-14.4
F-15C	75.0	77.6	- 2.6
B-52	77.7	82.7	- 5.0

Cannibalization Rates

The fact that fewer parts were available to fix jets created another problem all by itself. Aircraft cannibalization (Cann) is a common practice when a given part is not immediately available in the supply system. Canning aircraft parts during AWOS became a necessary evil in order to reduce the number of broken jets due to the extended supply pipeline under TLM. (figure 3). Those who saw TLM as the answer to our logistical challenges stated that TLM would not impact mission readiness. This was one of the fallacies of TLM. Without readily

available parts, maintenance personnel had to resort to cannibalization, significantly increasing the workload and in some instances, degrading the life of the LRUs most frequently canned.

During Operation ALLIED FORCE, many weapon systems saw a sharp increase in cannibalization rates (Table 3). To reduce this trend, USAFE/LG directed the establishment of Contingency High Priority Mobility Support Kits and the formation of Centralized Intermediate Repair Facilities, which will be discussed later.

Table 3 Cannibalization Rates[5]
***** (Rate = total aircraft + total Canns/sorties flown * 100)

Acft Type	Sorties	Hours	# Canns	Cann Rate *
B-1B	357	1657.5	43	12.0
B-52H	761	5193.4	62	8.1
E-3B	390	2761	109	27.9
E-8C	111	1215	12	10.8
F-15C/D	1351	6138	120	8.9
F-15E	1675	5332.9	293	17.5
F-16-40	2473	11682	309	12.5
O/A-10	4692	12640.5	502	10.7
KC-135	517	3393.9	59	11.4

Supply Logistical Support

USAFE personnel were faced with a series of challenges derived from the implementation of TLM. Unlike DESERT STORM, deploying squadrons had little or no intermediate-level maintenance support during AWOS. At the beginning of the conflict, USAFE was sitting at a 13.6 percent non-mission capable rate for supply.[6] This was the result of the elimination of base-level repair capabilities and extended supply pipelines. Under 3LM, all LRUs would go to the avionics back-shops where they were bench checked and repaired as required. Statistically, 30 percent of all removed parts were found serviceable and returned to the flightline for further troubleshooting.[7] This capability was diminished with TLM and directly contributed to increased non-mission capable rates for supply.

Under the TLM concept, all reparables from deployed locations must be shipped back to CONUS for repair, and then shipped back to the deployed location from CONUS to support requirements. As part of the Lean Logistics concept, major commands directed units to streamline their Mission Readiness Spare Packages (MRSP) kits to bare minimums to reduce airlift requirements. This reduction, plus the elimination of base-level repair, created a significant shortfall in critical aircraft parts from 1993 to present (figure 4).

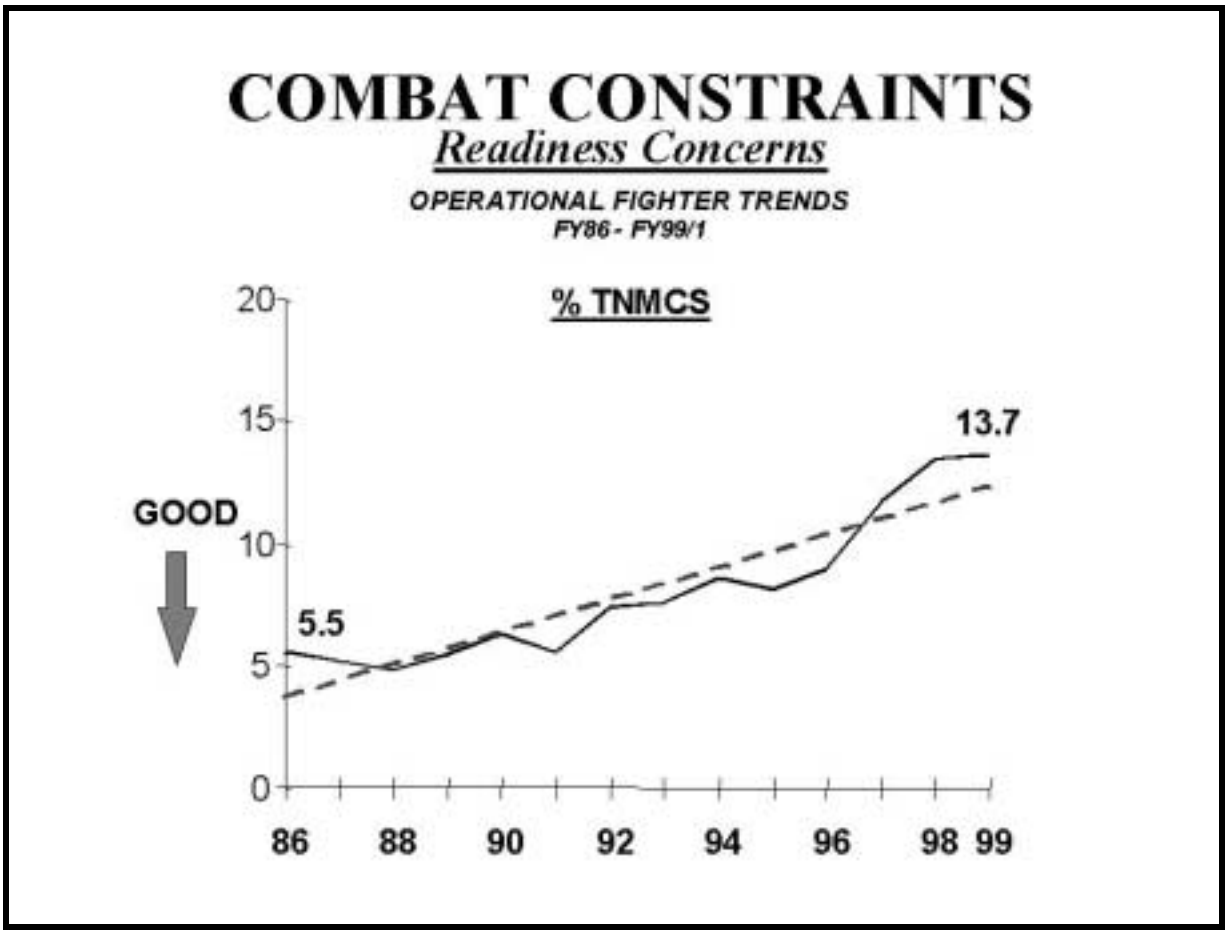

Figure 4 Total Non-Mission Capable Rate for Supply (TNMCS)[8]

A comparison of the supply rates between DESERT STORM and ALLIED FORCE reveal that the percentage of aircraft out-of-commission for parts increased from 5.5 percent to 10.4 percent.[9] The elimination of intermediate-level repair capability at the deployed location can account for the significant decrease in mission readiness due to supply. Another factor

contributing to this negative indicator was the additional time required for parts to be shipped to the depots and returned to the AOR. The assumption that replacement parts would be readily available simply did not materialize. The end result was that maintainers were forced to cannibalize these parts from other aircraft.

Depot's Responsiveness

Air Force Materiel Command (AFMC) played a decisive role during the Air War over Serbia. AFMC deployed Combat Logistics Support Squadron (CLSS) personnel to support Operation ALLIED FORCE. In combat conditions, CLSS personnel quickly and expertly repaired battle-damaged aircraft, tackling some of USAFE's toughest maintenance challenges. CLSS personnel also provided critical support during aircraft phase inspections.[10]

AFMC's depot support under TLM faced many difficulties. According to USAFE/LG staff, there were occasions when it was difficult to reach the right person at a given ALC on weekends and after duty hours. There were instances when item managers actually stopped working urgent issues after close of business. [11] In order to get an answer, USAFE staff teams had to call a variety of management levels, ranging from first-line supervisors to ALC commanders. According to one staffer,

> "ALC support during off-hours was poor, particularly during grave shift. We often had to wait until start-of-day shift (0700-0800 local) to talk to someone that could provide answers. We did utilize ALC Battlestaffs and Command Centers, but even those organizations did not have the necessary after-hour point-of-contact lists for every conceivable parts problem. Additionally, weekend support was even more difficult and frustrating, especially with contractors. Often the "On-Call" person could not be reached. It is imperative that someone "On-Call" needs to respond ASAP, not the next day!" [12]

Overall, the ALCs did play a vital role in the success of Operation ALLIED FORCE by providing critical logistical sustainment during the operation. The findings concerning logistical responsiveness highlight the limitation of relying on TLM to support contingency operations.

USAFE's Logistics Initiatives

Two weeks after the launch of Operation ALLIED FORCE, the USAFE Logistics staff was staring at a dismal 13.6 percent non-mission capable rate for supply.[13] The staff realized that the insufficient quantities of spares in the MRSP and the lack of organic repair capability were at the root of the supply problem. On 3 April 1999, the USAFE/LG issued a message to headquarters Air Force advising them that they would be forced to create supplemental supply kits and establish intermediate-level facilities in order to support the war effort.[14] By issuing this message, USAFE/LG abandoned the TLM concept to successfully support the war effort.

Contingency High Priority Mobility Support Kits

The purpose of the Contingency High Priority Mobility Support Kits (CHPMSK) was to provide additional spares to augment the MRSP kits. These were necessary to support requirements in addition to the MRSP authorizations because under the AEF concept, most units deployed with limited maintenance capability to keep the logistics footprint to a minimum.[15] The decision to create CHPMSK was based on the high non-mission capable rates for supply (TNMCS) experienced my most strike aircraft. This move by itself did not alleviate the sustainment issue during Operation ALLIED FORCE. As a result, the USAFE logistics staff had to take one additional step to correct the TLM crisis.

Centralized Intermediate Repair Facilities

To improve sustainment of combat operations, HQ USAFE established Centralized Intermediate Repair Facilities (CIRFs) at selected locations to improve mission support by reducing transit time and costs. The CIRFs provided intermediate-level maintenance for avionics, targeting/counter-measures pods, engines, booms, and phase/ISO inspection for the units in the theater (table 4).[16] By doing this, USAFE restored many of the critical logistical

requirements needed to support combat operations. By centralizing spares management, USAFE was able to push parts to the units with the highest priority of need. Additionally, CIRFs produced synergy by reducing the number of items returned to the U.S. for repair. Approximately 44 percent of all TLM items screened by the CIRFs were found serviceable and returned to the originating units.[17] Furthermore, CIRFs provided intermediate support for deploying units who had inadequate MRSPs. Finally, CIRFs maximized economy of scale by allowing cross-cannibalization of broken parts (SRUs). [18]

Table 4. Centralized Intermediate Repair Facilities during AWOS

CIRF Location	Description	Aircraft Type
Lakenheath	Avionics	F-15
Mildenhall	Avionics	KC-135
Spangdahlem	Avionics/Pods	F-16
Aviano	Avionics/Pods	OA-10

Summary

This chapter discussed the logistical effectiveness of TLM during Operation ALLIED FORCE. Not all of the decline in aircraft mission capability can be attributed exclusively to TLM, but the steep increase in non-mission capable aircraft for supply during OAF in contrast to DESERT STORM can be accredited in part to the implementation of TLM. USAFE personnel faced a tremendous logistical challenge, but demonstrated incredible initiative and courage by establishing CHPMSK and CIRFs to keep the logistics pipeline open. These concepts require further study in order to reap the full benefits for future contingencies.

Notes

1. Headquarters United States Air Force, *The Air War over Serbia*, *Aerospace Power in Operation Allied Force*, Draft Initial Report (Washington, D.C.: Office of Studies and Analysis, December 1999), 1.

2. Headquarters United States Air Force in Europe, Logistics Directorate, Kosovo After Action Report (Ram stein, Germany: Director of Logistics, 1999), 30.

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[3.] Air Force Historical Research Agency, *Noble Anvil Statistics vis a vis Desert Storm,* IRIS no. 02063372 (Maxwell AFB, Alabama: Office of Studies and Analysis, 1999), 1.

[4.] Ibid.

[5.] Air Force Historical Research Agency, *Monthly Weapon System Statistics*, IRIS no. 02063367(Maxwell AFB, Alabama: Office of Studies and Analysis, 1999), 3.

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[13.] Air War over Serbia Fact Sheet, 3.

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Part 4

A New Approach: Combat Repair and Enhancement Program

> *A real knowledge of supply and movement factors must be the basis of every leader's plan; only then can he know how and when to take risks with those factors, and the battles are won only by taking risks.*
>
> — George V. Higgins

Air Force Doctrine Document (AFDD) 2-4, "Combat Support" states that as logisticians, we must develop the capability to deploy lean but effective equipment and personnel packages to forward locations. It goes on to state that:

> The basic foundation of combat support is a motivated and ready force tailored, organized, trained, and equipped to accomplish tasks. Combat support leaders should always be looking for ways to **optimize** their forces to more effectively and efficiently support the warfighter. For example, competitive sourcing and privatization initiatives may reduce cost but could impact how forces are organized. Combat support operations in the twenty-first century will continue to require a highly responsive and agile combat support force. The success of combat support depends on **flexibility** in adapting to evolving military strategy, budget constraints, and emerging technology advances.[1]

The advent of TLM prior to the Air Force's implementation of the AEF concept brought new logistical challenges for the aircraft maintenance community. Gone was the intermediate-level repair capability as well as significant portions of critical MRSP kits. As a maintainer who sat many times on the "pointy head of the spear," I often wondered if there was a better way of doing business. This chapter will introduce a concept that can potentially improve overall combat capability and base self-sufficiency by exploiting state-of-art repair techniques.

Gold Flag Program

Introduction

For decades, aircraft repair technicians condemned many aircraft parts with an Expendability, Recoverability, Reparability Code (ERRC) of XB3, or XF3. Technicians did not have the time, equipment or the technical data necessary to find and repair faulty sub-components. Very little ingenuity or initiative was encouraged to build repair procedures or to find repair centers for these parts. At that time it was simply more expedient to purchase a new part. Back in 1990, Colonel Richard Zwieg had a vision concerning the future of logistics:

> We can not continue down the same road and throw away hundreds and thousands of dollars. We have to take a positive long lasting quality approach by attempting to repair the parts that were up to this time taboo or hands off.[2]

Benefits of the Gold Flag Program

The result of this vision became know as the Gold Flag Program. The Air Force Gold Flag Program's main objective was to optimize Air Force self-sufficiency by repairing previously discarded components. The Gold Flag office identified high demand or high dollar assets and investigated the feasibility of repairing assets either locally or through contract repair. Normally, items coded XF3 were routed to the appropriate back shop for repair. If the back shop could not repair the item, the item would be sent to the Gold Flag office for repair.[3]

Gold Flag technicians have developed the capability of repairing circuit cards, panels, and black boxes. Specialists assigned to this section are highly qualified technicians capable of repairing miniature/microminiature circuit cards. The technicians have expanded their expertise by developing techniques to excavate and repair down to seven layers in a multi-layered circuit board. They utilize state-of-the-art-troubleshooting equipment including the *Huntron 5100ds* with the *Robitic Prober* for troubleshooting circuit cards[4]. The *Huntron Tracker* is used to

develop and learn circuit cards electronic signatures. This data is now stored in the shop computer's hard drive for use in Gold Disk development. If Gold Flag technicians can't repair a given part, they will research potential candidates of repair through contracting sources.

Transitioning Gold Flag to the Combat Repair and Enhancement Program

Air Combat Command (ACC) is leading the Air Force's Gold Flag program and has had much success in repairing previously discarted aircraft parts. The ability to repair mission critical parts (MICAP), XB3, and XF3 items has provided added combat capability and unit self-sufficiency. Gold Flag programs throughout ACC have increased combat capability by repairing and returning to service 7,202 expendable assets, resulting in $23.8 million dollars in savings for fiscal year 1999 alone.[5]

AFDD 2-4 states that the success of combat support depends on flexibility to adapt to evolving military strategy, budget constraints, and emerging technology advances.[6] Gold Flag can potentially provide AEFs with much needed *flexibility* by exploiting emerging technologies in miniature/microminiature circuit card maintenance. This transition from Gold Flag to a new Combat Repair and Enhancement Program (CREP) can optimize combat capability by repairing unserviceable parts that are zero balance (not available) in the AOR. This researcher would propose expanding the repair authority for CREPs from XB3 and XF3 items to XD2 and XF2 parts that are currently coded for depot repair only. This would eliminate shipment delays to CONUS depots, reduce cannibalization actions, and increase mission readiness. Although not formalized, ACC did deploy Gold Flag technicians and equipment during Operation ALLIED FORCE and produced some amazing results. By converting Gold Flag from the traditional repair of previously discarded parts to an AEF deployable CERP unit, we can achieve significant improvement in unit combat capability and self-sufficiency.

Implementing CREPs would not require additional manning or equipment. Much of the equipment needed by Major Commands to support this concept is already available at the many base-level Gold Flag offices. Under this research proposal, the first step would be to convene a Two-Level Coordination and Activation Process (TCAP) conference. Air Force Instruction 21-129, "Two-Level Maintenance Program," directs Air Staff to conduct TCAP conferences annually. The functional TLM managers attending the TCAP could establish a list of components that could be converted initially from TLM to CREP. The second step would be to establish manning positions and equipment to support the CREP flights. This step would not require additional manning or funding because most MAJCOMs (AMC, ACC, AETC) already have Gold Flag programs in-place. A one-year study would be recommended to validate the savings in cost avoidance (parts repaired, not purchased) and reduction of cannibalization actions.

Summary

This chapter discussed an initiative that would significant improve the current TLM system. The Combat Repair and Enhancement Program consists of an integrated deployment package of the current Gold Flag Program. Air Combat Command has utilized this program with significant savings in cost avoidance and reductions in TNMCS rates. Integrating CREPs to current AEF deployment packages would improve combat support at deployed locations by establishing organic repair capabilities at unit level with minimum investment in equipment and personnel. A required step for implementing CREP would include conducting an annual TCAP conference to identify which parts should be converted from TLM to CREP.

Figure 5 CREP Deployment Pallet

Notes

[1.] Air Force Doctrine Document (AFDD) 2-4, *Agile Combat Support*, November 1999, 6.

[2.] United States Air Force, Air Combat Command, Twentieth Fighter Wing., *The Gold Flag Program* (Shaw AFB, North Carolina: Quality Assurance Flight, August 1996), 1.

[3.] Ibid.

[4] Captain William P. Quiñones, "Circuit Board Repair and Base Self-Sufficiency," *Air Force Logistics Journal 17*, no. 1&2 (Winter-Spring 1993), 1.

[5.] United States Air Force, Air Combat Command, Twentieth Fighter Wing, *Gold Flag Program Conference*" (Shaw AFB, North Carolina: Quality Assurance Flight, November 1997).

[6.] AFDD 2-4, 7.

Part 5

Conclusions and Recommendations

> We cannot become confused about the fundamental purpose of our armed forces. That purpose is their ***readiness*** to fight and win our nation's wars.
>
> — General Fogleman

Two-Level Maintenance Program Assessment

TLM brought sweeping changes that impacted every aircraft maintenance operation in the United States Air Force. These changes were necessary to a degree because of budgetary reductions and force reduction during the early 1990s. TLM supporters viewed it as the primary means of improving combat capability by reducing the logistical footprint. TLM did indeed accomplish this, but not without degrading supportability and time-definite resupply, two of the Air Forces' core combat support principles.[1] This chapter will present the conclusions of this research and provide some solutions that can be applied to TLM.

Incompatibility with Expeditionary Mission

TLM was built before the Air Force evolved to an expeditionary mission. The shift from a massive logistical structure during DESERT STORM to a much leaner mobility footprint during Operation ALLIED FORCE was based on the rapid movement of assets from CONUS depots to the AOR. The assumption was that as aircraft components failed, replacement parts would be

immediately shipped via express carriers in minimum time. As it turned out, depots did not have spare assets in their pipeline ready for shipment to the deployed units.

Accumulated maintenance data shows that after TLM implementation, the average repair cycle time for critical components actually increased. The Air Force Audit Agency was critical of the Air Logistic Center's responsiveness and recommended developing specific performance metrics to meet operational requirements.

Command and control between servicing depots and war-fighting units became a big issue during Operation Allied Force. Many staff officers expressed their frustration in their after-action reports stating that it was very difficult to get a hold of the point-of-contacts at several Air Logistics Centers during mid-shift operations, weekends, and holidays.

Elimination of Intermediate-Level Base Repair

TLM drastically reduced intermediate-level repair capability at base level. Although the impact can't be easily seen during peacetime operations, it became painfully visible during Operation ALLIED FORCE. The USAFE staff took drastic measures to minimize this impact by establishing Centralized Intermediate Repair Facilities. Spooling this capability from the ground up prior to a contingency is not a good idea. It requires specialized equipment and trained personnel. Maintaining this capability for expeditionary aerospace forces will become a critical necessity for future operations.

Aircraft Cannibalizations

TLM advocates discarded concerns that its implementation would force maintenance personnel into additional cannibalization actions due to lack of parts, and increased repair timelines. This concern became a reality and the data presented on figure 2 shows how cannibalization actions skyrocketed from fiscal year 1993 to present.

TLM was the key element of the Lean Logistics Movement of the early 1990s. By significantly cutting the number of parts in the MRSP kits, equipment, and personnel for AEF deployments, aircraft sortie generation had to rely on cannibalization actions that added additional wear and tear on removed components.

Transportation Dilemma

One of the assumptions made by TLM was that the Air Force would not have to purchase additional parts to compensate for the longer repair pipeline. Express service made this assumption credible, based on the idea of just-in-time deliveries. AFDD 2-4 states that:

> These resupply measures can also be used in reverse to provide a pipe-line to return reparables to overhaul sites. The "agile logistics" concept requires fewer spares to be used more efficiently. For the concept to work, reparables cannot accumulate either in theater or in transit.[2]

In many instances when parts were available, they did not arrive expeditiously utilizing express carriers such as Federal Express or DHL. The experience during ALLIED FORCE was that express service did not always work, mainly because of Customs' bureaucratic holdups and limited weekend and holiday deliveries in host countries.

Conclusion

This researcher concluded that TLM was implemented without sound strategic and operational doctrine. Air Force Doctrine Document 2-4 states that responsiveness, sustainability, and time-definite resupply are critical combat support functions needed to guarantee successful deployment and sustainment of operational aerospace forces.[3] These key functions were compromised with the reduction of intermediate-level base level capabilities and its transfer to the depots. The result of TLM was decreased combat capability.

Specific Recommendations

This study concluded that the ability to repair unserviceable assets in the AOR is critical to sustaining combat operations. While the jury is still out on whether TLM should be retained or eliminated in its entirety, the logistical community can take immediate steps to improve the current logistical system. We can begin this transformation by convening a Two-Level Maintenance Activation and Coordination Process (TCAP) conference. TCAPs were held in the past by different Air Logistics Centers to provide MAJCOMs with a forum to analyze problems with TLM assets and take proper corrective actions. Convening a TCAP would provide a forum where all avionics experts could meet to analyze current performance and initiate program adjustments.

Increasing Unit-Level Self-Sufficiency (CREP)

Chapter 4 discussed in detail how the current Gold Flag program could be transformed into the Combat Repair and Enhancement Program. Just as the Air Force uses air battle damage repair (ABDR) teams, deployed CREP teams could significantly improve combat capability by quickly turning defective LRUs through the use of mobile diagnostic equipment to isolate and repair circuit cards in the field. Converting Gold Flag to CREP would require minimum investment in equipment and personnel. Additionally, it would reduce airlift requirements for assets requiring transportation back to CONUS depot facilities. These cargo aircraft could then be utilized to support other airlift requirements.

CREP implementation would begin by convening a TCAP to determine which TLM components could be more easily converted to CREP. The next step would be to add the equipment and personnel requirements to the unit's UTC package. Most of these requirements are already in place at wing-level Gold Flag flights.

Prepositioning of Supply Assets

As Congress became painfully aware of the "shallow force" threat facing the military in the late 1990s, they re-apportioned funding to purchase aircraft parts to reverse the downward trend in mission readiness (figure 1). This reversal provides the Air Force with the option to preposition MRSP kits, munitions, and associated aircraft equipment in support of contingency operations. Prepositioning mission-essential assets (MEA) forward is not a new idea; the Air Force first used prepositioning during the Berlin crisis and currently maintains a fleet of ships containing munitions to support contingency operations.[4] The idea of prepositioning MEAs fits well with the current AEF concept, which requires rapid response to global crises. This concept has been studied thoroughly by RAND who concluded that:

> Comparing systems with and without prepositioning, the systems with prepositioning show advantages in most situations calling for large-scale quick-response capability.[5]

Items that would be ideal for preposition include engines and associated removal/installation equipment, munitions trailers, and MRSPs. These items can be prepositioned in CONUS at Air Logistics Centers, strategic aerial ports, overseas fighter bases, or at overseas strategic aerial ports. This concept has its limitations, to include increased operational costs, political problems related to acquiring and maintaining overseas storage facilities, and uncertainties concerning the security and wartime availability/serviceability of prepositioned materiel.[6]

Reengineering Base-Level Repair Cycle

In 1996, the Air Force Logistics Management Agency (AFLMA) conducted an Air Force Headquarters directed study on the feasibility of reengineering the supply pipeline. The study recommended combining the repair cycle functions of the Combat Oriented Supply Organization (COSO), Traffic Management Flight (TMF), Flight Service Center (FSC), and Maintenance

Supply Liaison (MSL) into one distribution office located at the work center level.[7] The study concluded the consolidating all portions of the base-level repair cycle could reduce processing time by as much as 33 percent.[8] This reduction in reparable processing time would streamline procedures, and reduce delays or errors between functional areas. This concept, when combined with the Combat Repair and Enhancement Program, could create potential synergistic effects for sustained combat operations at deployed locations.

Establishing Centralized Intermediate Repair Facilities (CIRF)

Chapter 1 described in detail the historical evolution of CIRFs and how it became a viable alternative for intermediate-level repair after the elimination of three-level maintenance. The studies identified improvements in sortie production, survivability, and resource management. The idea underlining this maintenance concept was that most of the available economies of scale can be achieved while possibly keeping pipelines shorter than when the depot repair system is the sole source of repair.

Operation ALLIED FORCE became a case study for the necessity of CIRFs during contingency operations at deployed locations. During this operation, the USAFE staff established four CIRFs (Lakenheath, Mildenhall, Spangdahlem, and Aviano) that significantly reduced repair turnaround times for avionics LRUs and engines designated as TLM assets.

There are many areas that require further study before we can fully embrace the centralized intermediate-level concept. Budgetary and manning restrictions must be analyzed to fully exploit the effectiveness of this concept.

Notes

1. Air Force Doctrine Document (AFDD) 2-4, *Agile Combat Support*, November 1999, 6-7.
2. AFDD 2-4, 15.
3. Ibid.

Notes

[4.] Major Joni R. Lee, *Prepositioning: A Logistical Concept for the AEF*, Research number AU/ACSC/107/1999-04 (Maxwell AFB, Ala.: Air Command and Staff College, 1999), 21.

[5.] Fort, Donald M., "Prepositioning and Airlift for TAC Rapid Deployment in the 1970s", RAND Corporation Memorandum RM-5559-ISA, 1968, 1.

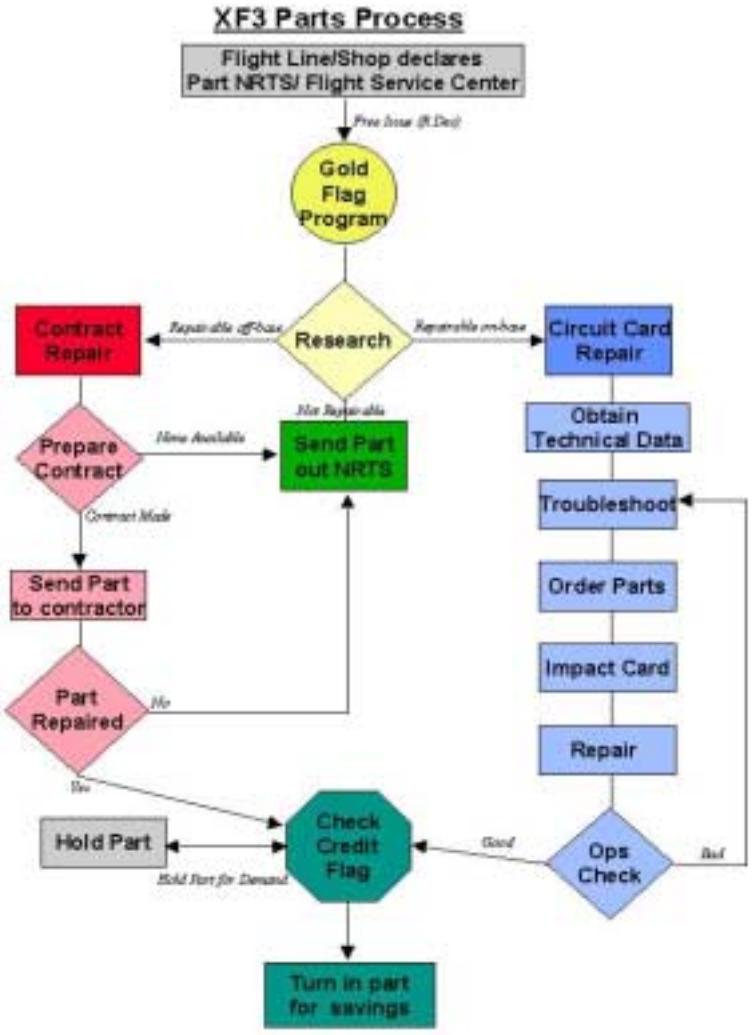
[6.] Ibid., 2.

[7.] Kramer, Capt Edward R., "Reengineering Base-Level Repair Cycle Processess", Air Force Logistics Management Agency, July 1996, p 18.

[8.] Ibid., 22.

Appendix A

Combat Repair and Enhancement Program Flow Chart



Glossary

ACC	Air Combat Command
AEF	Air Expeditionary Force
AFDD	Air Force Doctrine Document
AFMC	Air Force Materiel Command
ALC	Air Logistics Center
TLM	Two-Level-Maintenance
3LM	Three-Level Maintenance
ACS	Agile Combat Support
CHPMSK	Contingency High Priority Mobility Support Kits
CILC	Centralized Intermediate Logistics Concept
CIRF	Centralized Intermediate Regional Facility
CLSS	Combat Logistics Support Squadron
CRA	Consolidated Repair Activities
CREP	Combat Repair and Enhancement Program
DLA	Defense Logistics Agency
DOD	Department Of Defense
GAO	General Accounting Office
LRU	Line-Replaceable Unit
MEA	Mission Essential Assets
MICAP	Mission Capability, Highest Supply Priority For Parts
MRSP	Mobility Readiness Spares Packages
ONA	Operation Noble Anvil
PACAF	Pacific Air Forces
POC	Point of Contact
RAND	Research And Development Corporation
SRU	Shop-Replaceable Unit
TCAP	Two-Level Coordination And Activation Process
TLM	Two-Level Maintenance
TNMCS	Total Non-Mission Capable for Supply
USAFE	United States Air Force Europe

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