9-1997

Identification and Reduction of Bottlenecks Concerning MICAP Re-Supply of F-16 Weapons System Avionics Line Replaceable Units

Karl N. Muno

Patrick K. Pezoulas

AFIT/GTM/LAL/97S-6

IDENTIFICATION AND REDUCTION OF BOTTLENECKS CONCERNING MICAP RE-SUPPLY OF F-16 WEAPONS SYSTEM AVIONICS LINE REPLACEABLE UNITS

THESIS

Karl N. Muno
Captain, USAF

Patrick K. Pezoulas
Captain, USAF

AFIT/GTM/LAL/97S-6

AFIT/GTM/LAL/97S-6

IDENTIFICATION AND REDUCTION OF BOTTLENECKS CONCERNING MICAP RE-SUPPLY OF F-16 WEAPONS SYSTEM AVIONICS LINE REPLACEABLE UNITS

THESIS

Presented to the Faculty of the Graduate School of Logistics

and Acquisition Management of the Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Transportation Management

Karl N. Muno
Captain, USAF

Patrick K. Pezoulas
Captain, USAF

September 1997

Approved for public release; distribution unlimited

Acknowledgments

We wish to express our sincere appreciation to Dr. William C. Cunningham, our thesis advisor, and to Major Chris J. Burke, our thesis reader, for their patience, guidance, and direction during this research. Our thanks are offered to Mr. Greg Holevar and Captain Lori Bass, HQ AFMC/LGTR, for providing us with our thesis topic and overview. To Mr. Andy Figueroa and Mr. John Rhodes, HQ AFMC/LGTR, we thank you for providing the critical data we needed to complete our thesis. Mr. Don Stelts, 88th Supply Squadron, provided essential information regarding several supply related issues. Thank you for your timely assistance.

I (Karl) would like to give thanks to my Lord and Savior Jesus Christ for giving me the inspiration and strength (Phil 4:13) to complete this challenging program. To my wife, dearest friend, lover, and confidant, Joyce, of 13 years, thanks for putting up with my frustration and late hours. You made a terrific sacrifice home-schooling our children and I appreciate it very much. I love you more with every passing day. Kyle, Tyler and Austin, thank you for your obedience and help around the house, it made this year easier on the family. God truly blessed our family with your births. Finally, I want to thank Rick for being my thesis partner and helping to produce and submit an excellent product. Good luck to you in the future.

I (Rick) would like to thank my dearest wife, Ann Catherine, for her tremendous support during the last 15 challenging months. To my mother, thank you for your unending caring and words of support. I am truly indebted to you. Finally, to Karl, thank you for your friendship and teamwork. I made it because of all of you—take care.

Karl N. Muno　　　　Patrick K. Pezoulas

Table of Contents

Page

Page

List of Figures

List of Tables

List of Acronyms

Acronym	
2LM	Two Level Maintenance
AC	Canceled shipment
AE	Item Availability
AFLC	Air Force Logistics Command
AFMC	Air Force Materiel Command
ALC	Air Logistics Center
AO	Requisition
AS	Shipping Status
BB	Backorder
BC	Contract for repair
CLM	Council of Logistics Management
CMOS	Cargo Movement Operating System
CONUS	Continental United States
CREP	Contract Repair Enhancement Process
D6	Receipt
DAAS-C	Defense Activity Address System-Center
DIC	Document Identifier Code
DDOU	Defense Depot Ogden Utah
DLA	Defense Logistics Agency
DoDAAC	Department of Defense Activity Address Code
DREP	Depot repair Enhancement Process
DTS	Defense Transportation System
EDI	Electronic Data Interchange
EIS	Executive Information System
ETADS	Enhanced Transportation Automated Data System
FAD	Functional Area Designator
FQ	Funding Code Requirement
GTN	Global Transportation Network
ICP	Inventory Control Point
LRT	Logistics Response Time
LRU	Line Replaceable Unit
MICAP	Mission Capable
NMCS	Not Mission Capable Supply
NRTS	Not Repairable This Station
NSN	National Stock Number
PACAF	Pacific Air Forces
RIC	Routing Identifier Code
SOLE	Society of Logistics Engineers
SRAN	Supply Requisition Account Number
TOC	Theory of Constraints
UMD	Unit Manning Document
UMMIPS	Uniform Materiel Movement and Issue Priority System
USAF	United States Air Force
USAFE	United States Air Forces Europe
VLIPS	Visual Logistics Information Processing System

AFIT/GTM/LAL/97S-6

Abstract

This thesis evaluates selected F-16 avionics Line Replaceable Units (LRUs) transiting the logistics pipeline in order to examine the existence of bottlenecks and explore potential solutions within the current Department of Defense (DoD) logistics reparable pipeline. A previous study reported that a reduction in the overall pipeline resupply time of at least one day equates to a savings of approximately $25.45 million (Hill et al, 1990:iii). Bottlenecks cause movement delays to the entities moving through the logistics reparable pipeline. The pipeline segments are: AO (requisition), AE (item availability), AS (shipment status), and D6 (receipt). The bottlenecks of concern are those that occur when normally allowed transit times are exceeded.

The transit times are set forth by supply and transportation priorities in the Uniformed Materiel Movement and Issue Priority System (UMMIPS). This study focuses on five specific NMCS avionics Line Replaceable Units (LRU) which are also two level maintenance parts for the F-16 weapons system. The shipment data set, retrieved from the Enhanced Transportation Automated Data System (ETADS), consists of 682 Air Force shipments from the period 1 July through 31 September 1996. The overall performance of the shipments was poor with approximately 83 percent failing to meet the authorized UMMIPS standard. This study revealed that the pipeline segment with the most bottlenecks is the AS segment. Of the 63 shipments evaluated (accompanied with shipping documents), 49 contained bottlenecks within the AS segment.

IDENTIFICATION AND REDUCTION OF BOTTLENECKS CONCERNING MICAP RE-SUPPLY OF F-16 WEAPONS SYSTEM AVIONICS LINE REPLACEABLE UNITS

I. Introduction

Chapter Overview

This chapter provides justification for this thesis by presenting the purpose and specific problems concerning the logistics reparable pipeline. Next, the chapter addresses the research justification and then states specific research questions and research assumptions. Finally, there is a summary of the research focus.

Purpose

The purpose of this study is to identify whether bottlenecks exist, where they exist, and offer potential reduction or elimination solutions to the bottlenecks within the current Department of Defense (DoD) logistics pipeline.

Specific Problem

Historically, customers within the DoD do not received their priority cargo shipments in a timely manner. This poor customer service has led to the Lean Logistics model to improve customer service. All branches of the armed forces are currently experiencing similar order-cycle delays. This thesis will center on Not Mission Capable Supply (NMCS) parts that are depot sourced. No lateral support items will be considered. Seven hundred and sixty-eight

NMCS shipment documents, the DD-Form 1348-1A Issue Release-Receipt Document, were retrieved from the Enhanced Transportation Automated Data System (ETADS) and analyzed. Of the 768 shipments, 641 exceeded the allowable Uniform Materiel Movement and Issue Priority System (UMMIPS) time standard. This is an 83.46 percent failure rate and is seemingly unacceptable for organizations desiring full mission accomplishment with reduced budgets. Knowing that this problem exists, the logistics pipeline was broken down into segments to possibly identify bottlenecks within the logistics pipeline. Bottlenecks are defined as the portion of a process that cause delay in the entities moving through the process.

Due to the overall scale of the problem within the DoD and the Air Force, it was decided to focus this thesis specifically on the F-16 weapons system, but with the goal to identify bottlenecks within the logistics reparable pipeline by segment and offer recommendations that may reduce or eliminate bottlenecks. The scope is further reduced to selected avionics line replaceable units (LRUs) of the F-16 weapons system. The shipment data set for these parts is collected from 1 July through 31 September 1996. If bottlenecks can be identified in the logistics pipeline and then be reduced or eliminated with no extra costs involved from the solution, this could help an active wing enhance its mission readiness while saving valuable resources.

Customers at Air Force bases in Europe have received NMCS F-16 Avionics LRUs in excess of 45 days from date of requisition to receipt. This violates the UMMIPS time standards, and is our motivation to attempt to identify bottlenecks within the logistics pipeline that could be causing lengthy shipment delays. This thesis focuses on the Air Force's logistics principles of responsiveness and economy (AFDD40, 1994:6). Responsiveness is synonymous with stock availability and the average number of days a customer's order spends within the logistics pipeline. Once the depot receives a request, it attempts to locate a replacement part from depot stock. If a part is available from stock, the depot directs shipment to the requesting base supply (AS). If the part is not in stock, the depot will attempt to locate the part at another base. When the part is received at base supply, a message (D6S) is created acknowledging receipt of the part. The entire process according to the UMMIPS time standard should not take longer than 3.5 days within the continental United States (CONUS) and from 7.5 to 10.5 days to overseas destinations for NMCS parts.

Research Justification

Shipment delays can degrade mission readiness and effectiveness and result in excessive transportation costs. The goal of this thesis is to identify bottlenecks within the logistics reparable pipeline by segments and offer recommendations that may reduce or eliminate bottlenecks. The number one goal of the DoD Logistics Strategic Plan is to reduce logistics response times. "The new DoD goal is to achieve 72 hour delivery by September 1998 (i.e., one-day supply processing and two-day transportation delivery)" (Elliott et al, 1995:1-1).

In a time when the Air Force is downsizing and experiencing severe budget reductions, it would be prudent to implement improved processes that reduce costs. Every inch that can be taken off the logistics pipeline results in reduced customer inventories; and therefore, reduced taxpayer expenses (Elliott et al, 1995:v). A process that can be used to possibly reduce or eliminate bottlenecks is the Theory of Constraints (TOC). "A fundamental assumption of TOC is that a key to improving the performance of any system is to focus on the system's constraints, that is, the factors that limit the system's performance" (Chakravorty, 1996:223).

In a 1990 study by Headquarters Air Force Logistics Command (HQ AFLC), it was reported that a reduction of one day in the logistics pipeline for all parts entering the pipeline would result in a savings of $25.45 million (Hill et al, 1990:iii).

This study focuses on the F-16 weapons system in order to evaluate the logistics reparable pipeline for the avionics LRUs. Below, Table 1 presents the selected LRUs, with respective National Stock Numbers (NSNs), that were selected to gather data:

Table 1. Selected F-16 Weapons System LRUs

Item Stock Number	Nomenclature
1. 1270-99-251-2706WF	Wide-Angle Conventional Heads-Up Display Electronics Unit
2. 5985-01-212-2950WF	Radar Antenna
3. 1270-01-235-2370WF	Enhanced Fire Control Computer
4. 1270-01-396-6750WF	Programmable Signal Processor (Block 25-32)
5. 1270-01-399-8233WF	Programmable Signal Processor

Concentrating on these F-16 avionics LRUs is not by chance. According to the PACER LEAN project office, these five NSNs are the top five problem parts (Tucker, 1996). PACER LEAN is Headquarters Air Force Materiel Command's (AFMC) test program to verify whether the Depot Repair Enhancement Process (DREP) and Contract Repair Enhancement Program (CREP) is truly working as planned. Problem parts are those parts shipments that continuously exceed UMMIPS standards. These standards are used throughout the DoD and are set forth in DoDR4140.1R, DoD Materiel Management Regulation.

This thesis only considers depot-sourced NMCS parts; therefore, no evaluation of NMCS lateral support items was conducted because these items do not normally result in UMMIPS time standards being exceeded. Additionally, the Air Force cannot utilize lateral support as the first choice to support NMCS requests.

Research Questions

The following are the investigative questions concerning the identification and potential elimination of bottlenecks within the logistics reparable pipeline:

1. Do bottlenecks exist within the logistics reparable pipeline? If so, where are they and what are the causes?
2. How can the bottlenecks be reduced or eliminated?

Research Assumptions

Two assumptions are necessary to ensure the high priority of NMCS parts is maintained. First, the ultimate customer receipts the critical item the same day as the base supply receiving section. Second, due to a lack of actual requisition dates in ETADS for 95 percent of the shipments evaluated, it is assumed these requisitions were initiated the same day as the Julian date of the document number pertaining to the individual shipment.

Summary

This chapter provided the purpose of this study which is to identify whether and where bottlenecks exist and to offer potential solutions to reduce or eliminate them. Next, the specific problem is discussed that DoD customers are not receiving their NMCS shipments in a timely manner. Also, the research justification is presented that stresses how shipment delays can degrade mission readiness and effectiveness and result in excessive transportation costs. Finally, two important questions are offered that drive this study along with supporting assumptions.

II. Background and Literature Review

Chapter Overview

This chapter provides a review of the relative literature pertaining to logistics, Air Force depot logistics, the reparable logistics pipeline, the Defense Logistics Agency (DLA), Lean Logistics, PACER LEAN, and UMMIPS, ensuring a thorough background study was conducted for this research.

Logistics. Many definitions and viewpoints of logistics exist.

Webster's New Collegiate Dictionary defines logistics as "the aspect of military science dealing with the procurement, maintenance, and transportation of military materiel, facilities, and personnel" (Woolf, 1974:677).

According to Joint Pub 4-0, Joint Logistics Doctrine, "Logistics is the process of planning and executing the movement and sustainment of operating forces in the execution of a military strategy and operations" (Joint Pub 4-0, 1995:I-1).

The purpose of logistics, according to Air Force Doctrine Document (AFDD) 40,

> ...is to create and sustain force generation capabilities whenever and wherever needed to conduct military operations. On the broadest level, logistics is the key aspect of program management to acquire and sustain weapons systems. Air Force logistics at the base level includes the five specific functions of contracting, maintenance, supply, transportation, and logistics plans. (AFDD40, 1994:3)

The Council of Logistics Management (CLM), a professional logistics organization, defines logistics as:

> ...the process of planning, implementing, and controlling the efficient, cost effective flow and storage of raw materials, in-process inventory, finished goods and related information from point of origin to point of consumption for the purpose of conforming with customer requirements. (Lieb, 1994:21)

This definition applies to the military as well as civilian business.

The Society of Logistics Engineers (SOLE), another professional logistics organization, looks at logistics from an entire life-cycle point of view and defines it as "The art of science and management, engineering, and technical activities concerned with requirements, design, and supplying and maintaining resources to support objectives, plans, and operations" (Blanchard, 1992:4).

In the past few years, the differences between military logistics and business logistics have blended. Dr. Stephen Hays Russell concluded in his article, "Military Logistics and Business Logistics: Reexamining the Dichotomy," that:

> Both branches of the discipline have common logistics elements—inventory control, warehousing, packaging, transportation, distribution, etc. Both take a systems view of logistics. Both are now concentrating on issues of demand, databases, design, life cycle, and integration, although the focuses may vary. Both have a growing common vocabulary. Both look to logistics commanders for coordination, planning, and avoidance of sub optimization in logistics processes. (Russell, 1994:35)

There are seven logistics principles: responsiveness, simplicity, flexibility, economy, attainability, sustainability, and survivability (AFDD40, 1994:6). Table 2 describes each principle. This thesis will focus on the principles of responsiveness and economy.

Table 2. Logistics Principles (AFDD40, 1994:6)

RESPONSIVENESS	Get the right things in the right amount to the right place at the right time.
SIMPLICITY	Keep it simple.
FLEXIBILITY	Be able to operate in any environment.
ECONOMY	Be thrifty with resources.
ATTAINABILITY	Know what you can do before you do it.
SUSTAINABILITY	Remember: One must endure to win.
SURVIVABILITY	Survive first, then prevail.

Table 3 describes the seven logistics concepts which are pipeline security, total asset visibility, training, education and exercises, interoperability, availability, transition to and from war, and host nation support.

Table 3. Logistics Concepts (AFDD40, 1994:9)

PIPELINE SECURITY	Maintain secure and responsive pipelines to ensure a continuous flow of resources.
TOTAL ASSET VISIBILITY	Know where things are.
TRAINING, EDUCATION, and EXERCISES	Provide in-depth training and education, and realistically exercise major logistics elements at all levels.
INTEROPERABILITY	Pursue sufficient interoperability between Service, joint, and multinational forces to take advantage of economy of force benefits.
AVAILABILITY	Make weapon system availability the ultimate measure of logistics success.
TRANSITION TO and FROM WAR	Operate in peace as in war, but when that's not feasible, provide rapid mechanisms for a transition to war; don't forget the transition from war.
HOST NATION SUPPORT	Make effective use of host nation logistics resources.

Air Force Depot Logistics. Headquarters Air Force Materiel Command (HQ AFMC) controls the following Air Logistics Centers (ALCs): Ogden, Oklahoma City, Warner- Robins, Sacramento, and San Antonio. This study is only concerned with the Ogden ALC because it is the Inventory Control Point (ICP) for the F-16 weapon's system avionics LRUs. Ogden ALC performs maintenance work on strategic missiles, aircraft, air munitions, photo/reconnaissance, and landing gear (GAO, 1997:34).

Reparable Logistics Pipeline. In logistics, a pipeline is described as "the channel of support or a specific portion thereof by means of which materiel or personnel flow from sources of procurement to their point of use" (Joint Pub 4-0, 1995:GL-8). The customer, a flight-line crew chief, identifies a part needed to repair an F-16. If the part cannot be repaired on base, it is considered as Not Repairable This Station (NRTS) and is processed by base supply. A requisition for a replacement part (AO) is completed and it is sent to the responsible depot for filling. The Defense Depot Ogden, Utah (DDOU) is the responsible depot for the F-16 weapons system. The depot plays a major role in the order-cycle time and logistics pipeline. As an integral part of the total DoD logistics system, depot maintenance supports millions of equipment and over 17,000 aircraft (GAO, 1997:4).

Defense Logistics Agency. The Defense Logistics Agency (DLA) is the parent organization for the depot. The DLA was established to provide standardized item management and economical supply support to the DoD. According to "The DLA Corporate Plan", their organizational strategic plan, the DLA has implemented a new, improved method to manage their performance, and enhance customer service. This new method is called the Executive

Information System (EIS). The metrics for this system include responsiveness and quality, timeliness, and operating cost and operating efficiency. "The Air Force's storage pattern is similar to the other services. About 96 percent of its inventory is stored at 6 major locations and the other 4 percent at 105 locations" (GAO2, 1997:1).

> Between 1989 and 1995, DoD's forces decreased significantly. Active duty soldiers, sailors, marines, and airmen and airwomen decreased from 2.1 million to 1.5 million; attack and fighter aircraft dropped from 2,800 to 1,784; ships decreased from 570 to 372; and active Army divisions decreased from 18 to 12. For the near future, DoD is predicting less drastic decreases.
>
> Between 1989 and 1995, the inventories being held to support DoD's forces decreased from $92.5 billion to $69.6 billion. (GAO3, 1997:10)

DLA officials feel it is not necessary, from a cost-effectiveness and supply responsiveness standpoint, to store items at multiple locations. "They said that the services should not be concerned where the stock is physically located if DLA can meet the service's response requirements" (GAO2, 1997:7).

<u>Lead Time</u>. Only a cursory review of lead time is necessary because this research is concerned with a shipment only after it has entered the logistics reparable pipeline at the point of requisition. The exception to this rule is a part requiring contractor replacement.

> Lead time is an important element in the requirement determination process. In addition, lead time is a major factor in deciding the quantity of inventory to purchase when an item is initially introduced into the supply system. Further, as the DoD states, lead time also is a consideration as item managers decide how far in advance of actual needs a resupply order should be placed. (GAO4, 1997:29)

Lead time is the cumulative time from when it is decided to place an order until the order has been actually received, placed into stock, and ready for customer demand (Silver, 1985:65).

Lean Logistics. This concept integrates maintenance, supply, and transportation systems to ensure delivery of the right part to the user at the right place and the right time. For components with sufficient reliability and maintainability, it eliminates on-base repair shops while consolidating and reducing inventory. Lean logistics attempts to supply customer demands rapidly while saving money. Finally, "Lean Logistics replaces inventory size with speed. From the source of supply, along the lines of transportation, and into the customer's hands, the idea of Lean Logistics is to move fast. The faster the inventory of spare parts moves, the fewer parts required" (Ely, 1996:1).

PACER LEAN. This is a demonstration project for the Depot Repair Enhancement Process (DREP) and the Contract Repair Enhancement Program (CREP). The DREP is designed to broaden the depot's and customer's chance for success. Success is achieved through data which supports the repair process. "DREP focuses depot money and manpower on most urgent field requirements" (AFMC, 1997). The CREP goal is to "attain improved response times at equal or lower costs [than at depot repair facilities]" (AFMC, 1997). Some of the key CREP tenets are: establish long-term (3-5 year) flexible contracts with vendors, send reparable carcasses to the contractor, and reduce overall repair cycle time. The purpose of PACER LEAN is to test the logistics processes identified in DREP and CREP.

> PACER LEAN will be a pivotal step toward realizing the goals of Lean Logistics. As with the Lean Logistics approach, the customer comes first, improvements will be driven by process reengineering initiatives and standardized information technology will be leveraged where possible to attain resource requirement reductions. A challenging set of Quality Performance Measures (QPMs) will be used to evaluate progress toward achieving the program goals. These QPMs will be reviewed quarterly after the implementations begin, to ensure the command is driving the desired behavior. There will also be four command reviews of the program. These reviews are tentatively set to address the program start-up,

> procedures and systems, personnel and training, and future AFMC-wide implementation. As lessons are learned and issues and concerns are addressed during these reviews, necessary adjustments will be made to ensure the most dynamic program possible. (PACER LEAN Program Management Plan, 1996:3)

"The PACER LEAN program goals are to reduce the pipeline time and overall cost while improving customer support" (PACER LEAN Program Management Plan, 1996:3).

Theory of Constraints. As stated earlier in the introduction, the purpose of this thesis is to identify and resolve bottlenecks or constraints.

> The theory of constraints (TOC), [developed by Eliyahu Goldratt], is a continual improvement philosophy that focuses on the identification and management of constraints for organizational (global) goal achievement. In most organizations, a small number of constraints govern the overall level of performance. If these few constraints can be relieved, the entire organization's performance can be improved. (Tersine, 1994:426)

"A fundamental assumption of TOC is that a key to improving the performance of any system is to focus on the system's constraints, that is, the factors that limit the system's performance" (Chakravorty and Verhoeven, 1996:223). "A constraint is anything that limits the achievement of [a] goal" (Chakravorty and Verhoeven, 1996:224). Any reduction in system performance usually results in increased costs to the process owner as a result of inefficiency. As reported in the 1990 HQ AFLC/MMM study, improving performance of the pipeline by a one day reduction could result in a savings of $50 million. This study seeks to identify and offer suggestions to reduce or eliminate constraints within the logistics reparable pipeline.

The TOC is centered around a five-step process that includes:

1. Identify the constraints of the system.

2. Decide how to exploit the constraints.

3. Subordinating all other actions to exploit the constraints.
4. If necessary, work to elevate the constraints.
5. If a constraint is broken (i.e. ceases to be a constraint), return to Step 1 and repeat the process. (Chakravorty, 1996:226)

The five-step process has been very successful for many business organizations that have applied the TOC to improve their performance. For example, Spencer, and Wathen (1994) describe how Stanley Furniture Company applied the TOC to improve customer service by reducing delivery lead times. The company realized a series of reductions in delivery time by iteratively applying the five focusing steps to break three successive constraints: the first station of each assembly line, the order entry process, and the traffic shipping function (Chakravorty, 1996:226). "As a result of the actions taken at Stanley, over 60 % of the orders at the Stanleytown factory are now shipped within 7 days of receipt" (Chakravorty, 1996:226). The previous goal was 12 to 15 days, and 20 percent of the orders were late (Chakravorty, 1996:226). If the five-step process worked for Stanley, there is a probability of success within the Air Force's logistics reparable pipeline based upon the similarities of constraints between Stanley and the logistics reparable pipeline.

Uniform Materiel Movement and Issue Priority System. The Air Force uses the UMMIPS which establishes the requisition priority between the retail and wholesale levels. "This system was developed by the DoD to standardize supply and transportation procedures in all DoD activities. DLA is the DoD agency responsible for administering this system" (AFIT, 1990:7). It establishes the standards for movement of all DoD cargo by priority. The standards set the maximum allowable process and shipment time for the movement of all cargo. The foremost standard concerns NMCS parts. These parts are priority 01-03 and should result in the lowest UMMIPS time. Numerous customer complaints have centered around the fact that a majority of their NMCS parts exceed the established maximum allowable process and shipment time. This suggests that bottlenecks exist at one or more stages within the logistics reparable pipeline.

Summary

This literature review provides background information needed to understand the many factors that impacted this research. It describes a number of key terms such as: Air Force logistics, the logistics reparable pipeline, Lean Logistics, PACER LEAN, the Theory of Constraints, and the UMMIPS. Other subjects were also presented to provide the necessary background to perform this study.

The crux of this study focuses on the UMMIPS standards and identification of bottlenecks to reduce the logistics reparable pipeline. There are few research studies available that cover these areas. This study is the first to offer potential solutions to current bottlenecks within the logistics reparable pipeline.

III. Methodology

Chapter Overview

This chapter presents two critical questions that drive this study. The data methodology and collection methods used are described in detail. Numerous evaluations are performed from information obtained from the ETADS and related shipping documents (DD Forms 1348-1A and Government Bills of Lading). These evaluations result in the identification of existing bottlenecks within the logistics reparable pipeline.

Research Questions

This study is designed to answer the following questions:

1. Do bottlenecks exist within the logistics reparable pipeline? If so, where are they and what are the causes?
2. How can the bottlenecks be reduced or eliminated?

Data Methodology and Collection

This thesis concentrates on the identification and potential elimination of bottlenecks within the logistics reparable pipeline as it pertains to the F-16 avionics LRUs presented in Table 1. In order to determine whether bottlenecks exist within the logistics reparable pipeline, NMCS shipment data are used to conduct an analysis. The data used in this thesis are provided by HQ AFMC/LGTR and retrieved from the Enhanced Transportation Automated Data System (ETADS).

Each line of shipment information is divided into 14 categories. For the purpose of identifying bottlenecks, only the categories that identify the part and the time/date categories reflecting the different stages within the order-cycle and logistics pipeline are used. The data are compared to the UMMIPS standard to verify whether the individual shipments met or exceeded the standard. Also, this thesis is only concerned with the shipments that were received by the customer after the UMMIPS standard had been exceeded.

In addition to ETADS, the Issue Release-Receipt Document, DD Form 1348-1A were physically obtained and reviewed for accurate receipt dates. The data were retrieved for the five F-16 avionics LRUs that were selected for evaluation. The data covers the period from 1 July through 31 September 1996. This three month period provides a manageable data set and also represents an accurate picture of bottlenecks, if they exist, because NMCS parts are not fiscally constrained.

Data are separated and evaluated by overseas and CONUS location, theater of operation, individual bases, supply requisition account number (SRAN), and national stock number (NSN). These items are compared to the time standards specified in UMMIPS. Also, these time frames are listed by logistics reparable pipeline segment for specific theater of operation, e.g. CONUS is authorized seven days. The AO (customer request), AS (shipment status), D6S (customer receipt) times from the ETADS data, dates received and processed from the DD Forms 1348-1A, and FedEx delivery receipts are used for comparison with the UMMIPS standards.

In order to accurately identify bottlenecks within any system or process, an accurate measurement of total time spent in that system must be compared to the system standard. This thesis concentrates on the logistics reparable pipeline time which begins when a reparable LRU is requisitioned electronically, telephonically, or in person, and ends when the part is received by the requesting customer. **(Assumption: Receipt by the ultimate customer occurs the same day as supply receipt occurs.)** This assumption is based on the premise that NMCS parts are inherently high visibility assets and require an audit trail. The high visibility and high priority of NMCS parts require the supply representative at the receiving base to treat these items with expedited handling to prevent any unnecessary delay in making aircraft mission capable.

In order to evaluate the pipeline performance of LRUs as it pertains to the logistics reparable pipeline, the times are compared to the UMMIPS standard which is applied throughout the DoD. Currently an NMCS part is allowed from seven to 17 days in-transit time, depending upon the theater of operation, from requisition to customer receipt. These time frames include all segments of the logistics reparable pipeline.

The logistics reparable pipeline is divided into the following segments: requisitioning (AO), item availability (AE), shipment status (AS), and receipt (D6). Each segment represents a specific portion of the overall logistics reparable pipeline time and is the focus for deciding if and where bottlenecks exist.

The first review of the data revealed that over 4,100 lines of shipment information was too large to manage within the scope of this study. Each line was in the 80 card column format. Upon closer examination, it was discovered that a majority of the lines of shipments were not actually separate shipments. In fact, approximately two to four lines of information pertained to each shipment. Each line contains valuable information concerning the shipment. For instance, a line may begin with A01, which identifies the shipment as a requisition from an overseas location. Another shipment line may indicate whether an item was backordered (BB), contracted out for repair (BC), or was canceled (AC).

The first tier evaluation of the data is to remove all canceled shipments and incomplete or illegible shipment documents, a total of 59 shipments. There are 768 shipments remaining to evaluate the logistics reparable pipeline. Of the 768 shipments, 86 are from overseas locations. The remaining 682 shipments are consigned to active or reserve Air Force units throughout the CONUS.

Next, the data are divided into Overseas and CONUS location by identifying each base by its assigned SRAN/DoDAAC. The division of the data into separate tiers is essential to the identification of bottlenecks. Without these divisions it is difficult to identify whether bottlenecks occur Air Force wide, theater wide, or simply at one or a few locations within the Air Force.

A comparison of all the shipment times for the 768 shipments with the UMMIPS standards was conducted and of these, 641 shipments failed to meet the required standard, which is an 83.46 percent failure rate. This high failure rate can severely impact mission effectiveness, and is indicative of the existence of bottlenecks within the logistics reparable pipeline.

The second tier evaluation of the data involves the 86 overseas consigned shipments. Only 19 of these 86 shipments meet the UMMIPS standard, which equates to 78 percent of the overseas shipments exceeding the standard. Bottlenecks evidently exist at this level of division. Only two overseas bases, Kunsan AB, Republic of Korea (75%), and Elmendorf AFB, Alaska (100%), meet the standard consistently. The reason may be simply due to the intra-theater intermediate depot level repair facility located in Japan which allows Kunsan AB and Elmendorf AFB to have reparable parts repaired and returned more expediently and thus have a faster turnaround time than would be experienced from repair service at a major depot in the CONUS. However, the most significant change is the reduction in transit time. On average, it takes one to three days transit time within Pacific Air Forces (PACAF). This time would dramatically increase if the parts had to be shipped to a CONUS facility because of the additional transportation requirements.

The average transit time by UMMIPS standard is seven days between overseas and CONUS locations. If this process saves an average of four days transit time, that would equate to approximately a $100 million savings for all parts within the pipeline (Hill et al, 1990: iii). Ninety-six percent of the selected F-16 MICAP shipments to Dhahran AB met the 17 day UMMIPS standard. This is probably due to the amount of allowable time. Dhahran AB has regularly scheduled channel missions from Germany that allow parts to be received by customers several times each week. The UMMIPS standard allows Dhahran AB six days in addition to 11 days authorized for shipments to Germany to receive its cargo. Channel missions are scheduled, on average, three time per week. The bottom line is that Dhahran AB enjoys a three day cushion to meet the standard.

Of the 682 CONUS shipments, only 83 actually met the UMMIPS standard. The remaining 599 shipments exceeded the standard which represents an 88 percent failure rate.

The final piece of data needed is the actual receipt date by the customer. This date/time is found in the D6S report sent out by base supply. The actual dates and times indicating customer receipt are gathered from the DD Forms 1348-1A for the sample population.

The above information for the five NMCS F-16 avionics LRUs occurred between 1 July and 31 September 1996. In order to remove any bias from our data, 100 shipments were randomly selected from the 782 total shipments. The sample size of 100 shipments is large enough to account for lost, mutilated and incomplete documents. This sample size is also large enough to represent the five NMCS parts specifically chosen for evaluation within the logistics reparable pipeline. The 100 randomly selected shipments were organized in SRAN/DoDAAC format beginning with FB2027, Hill AFB, UT and ending with FB6716, New Orleans ANG, LA.

The next step in the evaluation process is to contact the Document Control section at each base by SRAN/DoDAAC and request a copy of each DD Form 1348-1A. These documents were requested because they offer an audit trail that ends at the destination base supply squadron's receiving section. In some cases, the documents requested were actually issues rather than receipts; therefore, additional steps were warranted. These steps include identifying the consignee (receiving base) and requesting another DD Form 1348-1A to verify date of receipt at base supply. These documents offer information helpful in identifying and locating bottlenecks within the logistics reparable pipeline and order-cycle process. This data collection consisted of only 42 actual documents being received from the base supply document control sections.

Of the 42 documents received, all contained legible and valuable information. These documents were evaluated for the actual date of receipt by the base supply representative. This date is annotated on the document in close proximity to the signature of the person signing for the NMCS part from either the commercial carrier or military representative. In most cases the signature was for receipt of these crucial parts from a commercial carrier. The reason for this is the large percentage of the random shipments received in the CONUS by CONUS consignees. Most bases within the CONUS are authorized to use overnight carriers to expedite the transportation of these high priority parts. In fact, of the 100 shipments only eight were destined to an overseas location.

The next step in the evaluation process is to gather additional ETADS data. The new data are retrieved from ETADS-FEP. This data indicate the date that each of the 100 shipments transited through each segment of the pipeline. The dates are needed to identify the location of the bottlenecks. The data also give the tracking number for each shipment tendered to an overnight carrier (FedEx). These tracking numbers are useful to request a copy of the commercial carrier's delivery receipt to verify the actual dates of receipt by the destination supply receiving section.

The data are segregated by NSN to evaluate the overall order-cycle time for each part from request to receipt. The actual order-cycle time is derived by subtracting the original request date/time from the receipt date/time. This time duration is then compared to the UMMIPS standard.

The final step in the process is the evaluation of the data by segment within the pipeline. This is performed by extracting the dates from the various data sources and placing them in order of occurrence in the pipeline. The dates will be compared with the time allowed by the UMMIPS standard for each segment to identify if a bottleneck does occur within the particular segment. If the dates are one or more days in excess of the UMMIPS standard at any one segment, this excess shipping time will constitute a bottleneck. The reasons for each bottleneck will be determined by evaluating each segment. In most cases, it is one or more processes that with a minor improvement can result in a reduction of a bottleneck. However, it is important to note that an improvement process has associated costs and they may be prohibitive to implement.

Summary

This chapter presented two questions that are critical to this study. The data methodology included the collection of shipment data from the three month period between 1 July and 31 September 1996. The data from this 90 day period provide an extensive yet manageable data set to search for bottlenecks. The data came from all Air Force bases with F-16 weapons systems and also grouped the data by CONUS and overseas location.

IV. Results and Analysis

Chapter Overview

This chapter presents the data analysis and results using the methodology presented in Chapter Three. All research questions are discussed individually in detail. The data analysis is used as support for the answers provided in each question.

Data Analysis

One of the reasons for this study is to identify bottlenecks within the logistics reparable pipeline. If these bottlenecks are truly bottlenecks, they will affect all reparable parts and all bases throughout the Air Force. Based on this assumption, each Air Force base should experience bottlenecks at the same location or locations within the order-cycle and logistics pipeline.

This study is concerned with bottlenecks that result in an average shipment time that exceeds the UMMIPS time standard. Table 2, shown below, identifies the specific times for each critical segment of the logistics reparable pipeline as set forth in the UMMIPS standard.

Research Question 1. Do bottlenecks exist within the logistics reparable pipeline? If so, where are they and what are the causes?

There are bottlenecks that, when reduced or eliminated, will result in a savings of time and money. By reducing a bottleneck, the amount of handling time or transit time should be reduced and therefore, the amount of direct labor hours should be reduced.

The data evaluation revealed there are both internal bottlenecks and external paperwork delays with respect to the logistics reparable pipeline. External paperwork delays occur at the base supply receiving section as a result of batch processing. Paperwork delays cause a misrepresentation of the data. It is highly likely that a NMCS part could already be on an aircraft and bound for the consignee. However, batch processing several days later into the SBSS will indicate a longer handling and processing time by the base. When in actuality the part is moving through the system in a timely manner. This situation can be solved with no additional cost to implement. Ensuring documents are input at the earliest opportunity into the SBSS is the solution.

This study found that 19 of the 100 randomly selected shipments were sent from the consignor via FedEx to the consignee. This does not mean that these are the only shipments that were delivered by overnight commercial air nor does it mean that these are the only shipments tendered to FedEx during the three month evaluation period. These 19 shipments simply reflect the number of shipments that have FedEx data assigned to them in the ETADS. ETADS is the source for data concerning the FedEx shipments. Also, these 19 shipments have FedEx tracking numbers. The FedEx delivery receipts were requested for evaluation, but FedEx could not comply with this request in a timely manner. A FedEx representative stated that FedEx uses the same numbers repeatedly. FedEx delivers over three million shipments per night and using the same numbers repeatedly simplifies their process (Gorman, 1997: E-mail).

The ETADS data and DD Forms 1348-1A are evaluated for FedEx performance. This is accomplished by properly identifying the date each shipment was tendered to FedEx and by also identifying the date that each shipment was received at the destination supply's receiving section. The date of the signature on the DD Form 1348-1A assists our study in the interpretation of whether the documents were batch processed at the receiving section, resulting in an inaccurate reflection of the actual receipt date of shipments. If the shipment receipt date annotated on the DD Form 1348-1A is earlier than the Julian date entered into the Standard Base Supply System (SBSS), this indicates the documents were received by base supply and then processed some time after the actual date of receipt—batch processing.

Evaluation also shows that all 19 shipments were delivered by FedEx on-time for a 100 percent customer satisfaction rate. The shipments were in-checked by the receiving section the following business day after being tendered to FedEx. A small number of the shipments were tendered to FedEx for second-day delivery instead of overnight delivery. This service was requested over a weekend. Currently, FedEx offers weekend delivery, but the shipper must pay a much higher fee for this service. This fee usually includes a special Saturday delivery fee of $15.00. Furthermore, Saturday delivery is not offered for parts weighing over 150 pounds. Three of the five stock NMCS part evaluated in this study weigh over 150 pounds. In the limited number of cases in this study where this occurred, it appears that the shipping agency was not willing to pay higher fees or it was simply not necessary to ensure next day delivery on a weekend.

Of the 100 randomly selected shipments, only five were requisitioned using the SBSS method, while the remaining 95 shipments were requisitioned via telephone. The telephonic requisitioning method may offer the customer an expedited requisition when compared to the standard method, but the downside to this method is the loss of control by base supply in the requisitioning process.

Only 63 of the 100 DD Forms 1348-1A were received. This 63 percent response rate is due to many different factors such as inadequate quality assurance and safeguarding of data backup systems, lost data, and mutilated or illegible shipping documents. Data were also lost due to inadequate safeguards and quality assurance at several bases that could not provide any documentation due to faulty computer compact discs. The "bad" disks did not capture the data being saved or had integrity problems. In a few cases, the data requested were completely lost. Our study identified 15 requested documents that were irretrievable due to the documents being lost. The most common problems associated with the retrieval of the information was receiving mutilated or illegible documents. Eighteen documents that were received had one of these problems and could not be used in the sample.

The data analysis for the overall UMMIPS performance for overseas and CONUS shipments is shown in Figure 1. It is clear that a majority of the shipments, 682, do not meet the UMMIPS standard. This is consistent with the previously stated definition of a bottleneck. Therefore, the data in the table indicate sufficient evidence that bottlenecks exist within the logistics reparable pipeline.

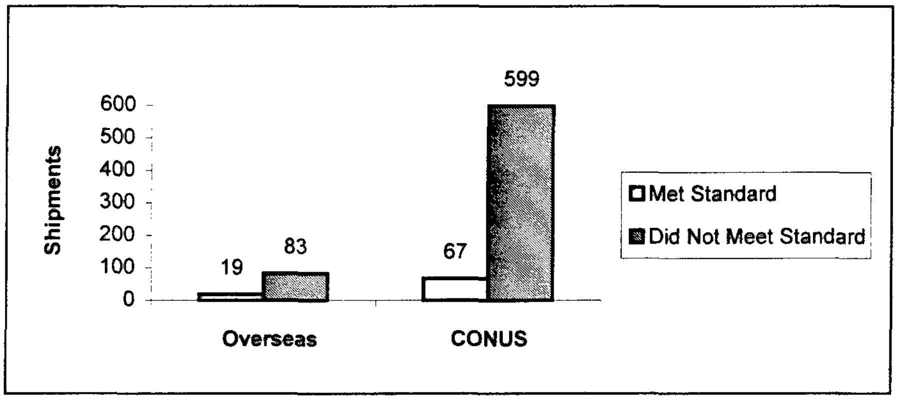

Figure 1. Overall CONUS and Overseas UMMIPS Performance

Figure 2 identifies the overall UMMIPS performance for overseas shipments by theater. The table presents the data by overseas theater of operation to show UMMIPS performance. This data set helps identify whether bottlenecks occur Air Force wide or only within certain theaters of operation. From the data, it is clear that bottlenecks exist Air Force wide. Over 65 percent of the total shipments in each theater exceed the UMMIPS standard.

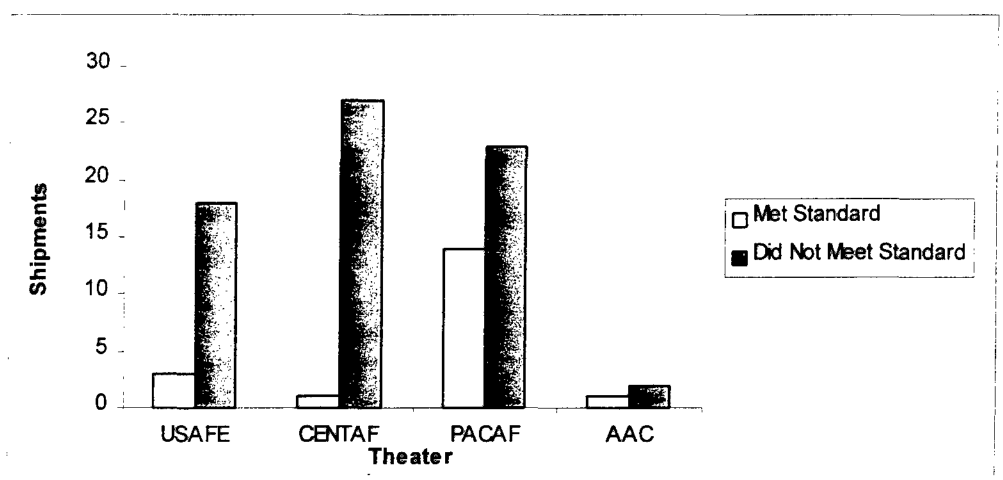

Figure 2. Overall Overseas UMMIPS Performance

Figure 3 presents the results of the randomly selected overseas shipments and the respective UMMIPS performance by theater. This table is also divided by theater to determine if bottlenecks exist Air Force wide or within specific theaters. The data clearly indicate that there are bottlenecks in the logistics reparable pipeline in at least three of the four theaters. Important to note is the Alaskan Air Command did not have any randomly selected shipments in the evaluation.

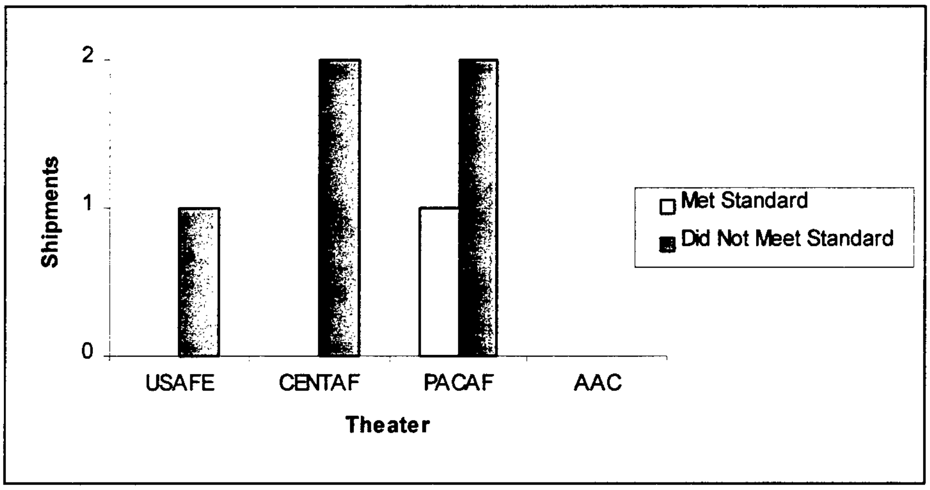

Figure 3. Random Overseas UMMIPS Performance

Figure 4 presents the results of the randomly selected CONUS shipments and the respective UMMIPS performance. The 57 shipments represent the sample from the 100 randomly selected shipments. The DD Forms 1348-1A received for each of the 57 shipments provide the actual receipt dates and times to verify actual overall pipeline time. The data indicate that approximately 44 percent of the shipments met the standard and that bottlenecks also exist within the CONUS theater.

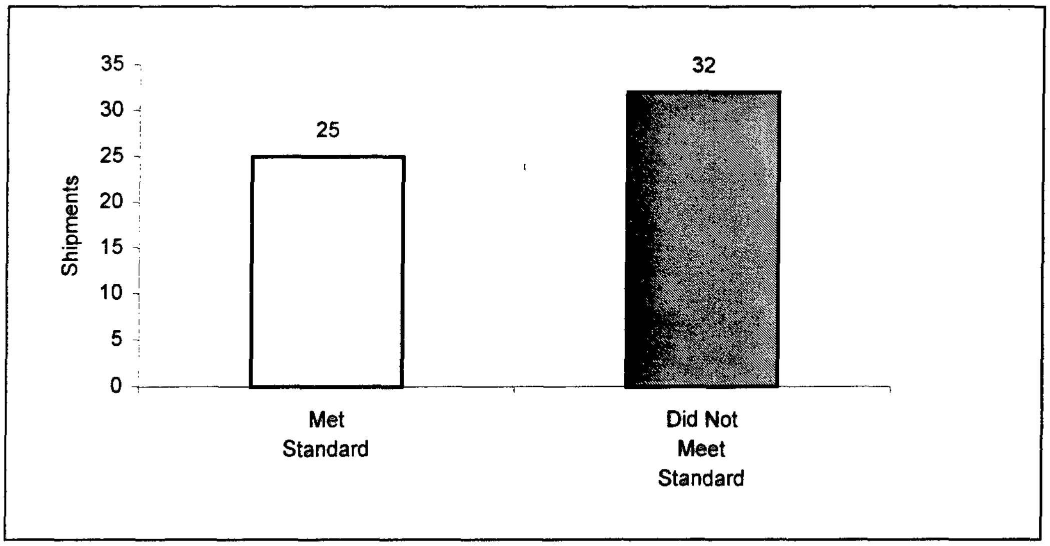

Figure 4. Random CONUS UMMIPS Performance

The data described above, concerning the initial evaluation of the 63 random selected shipments, verify bottlenecks exist within the logistics reparable pipeline Air Force wide. The next logical step is to identify the location within the pipeline. In order to do this, the data set must be evaluated by pipeline segment. The pipeline is divided into the following segments: AO (requisitioning), AE (item availability), AS (shipment status), and D6 (item receipt). These are the segments referred to in the remainder of this chapter.

The data set in Figure 5 indicates that bottlenecks exist within the pipeline at various segments. However, the most prominent location is the AS segment of the pipeline with 49 shipments exceeding the UMMIPS standard by more than one day. After completing the data interpretation concerning the number of bottlenecks within each segment The data analysis consists of 63 shipments with accompanying DD Forms 1348-1A. The total number of bottlenecks is 90 which is derived in the following manner: 49 shipments in the AS segment, 23 shipments in the AE segment, and 18 combined shipments (more than one bottleneck per shipment). It is possible to have more than one bottleneck for a single shipment within the pipeline.

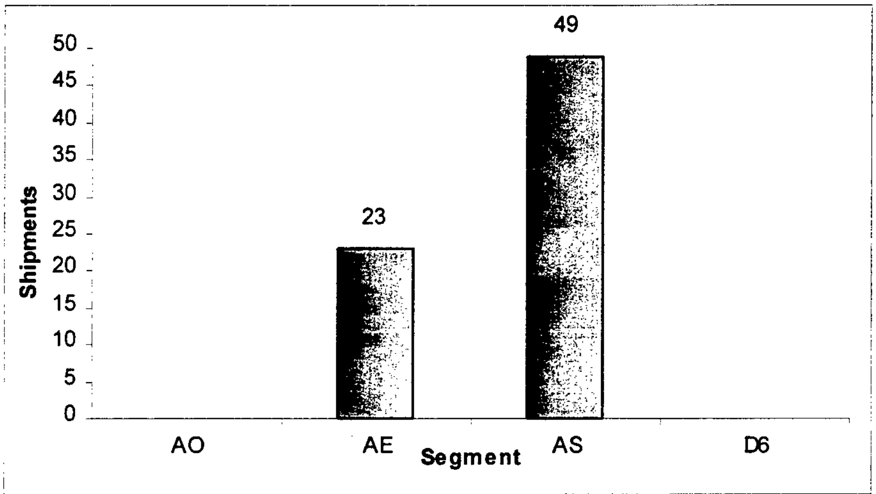

Figure 5. Pipeline Segment Bottlenecks

The purpose of Table 4 below is to provide a synopsis of two shipments from date of requisition to date of receipt. The documents used to illustrate the movement of these shipments through the pipeline is a small representation of the overall performance of the shipments evaluated in this study.

Table 4. Pipeline Evaluation of Randomly Selected NMCS Shipments

Document Number	Location	(AO) Requisition	(AE) Availability	(AS) Shipping Status	(D6) Receipt
FB485562259003	Cannon AFB, NM	6225	6228	6228	6233
FB483062439032	Moody AFB, GA	6243	6243	6243	6247

From Table 4, a NMCS part, document number FB485562259003, was requisitioned on the 6225 (12 Jul 96) day. A serviceable item was not available for shipment until the 6228 (15 Jul 96) day. This three day period exceeds the allowable one day UMMIPS standard for item availability. The item was shipped on the 6228 (15 Jul 96) day and was received by the base supply receiving section on the 6233 (20 Jul 96) day. This equates to five days CONUS intransit time and exceeds the UMMIPS standard of one day. Therefore, there is a possibility of having more than one bottleneck within the pipeline for a single shipment. It is also possible that a shipment meets the UMMIPS standard, but there is a bottleneck within its pipeline. For example, another NMCS part, document number FB483062439032, was requisitioned on Julian date 6243 (30 Jul 96) and shipped by the transportation cargo movement section on the same day. However, the shipment was not accounted for by base supply until its receipt on the 6247 (3 Aug 96) day. This shipment period has a total pipeline time of four days and a transportation intransit time of four days; therefore, the transportation portion exceeds the UMMIPS standard of one day and thus is a bottleneck.

According to the UMMIPS standard, a CONUS shipment is allowed 1.5 days to pass through the requisitioning process (AO). This time period begins when the customer coordinates with their base supply representative to requisition a part. A majority of requisitions are performed via telephonic means. This creates an auditing problem as to exactly when the actual call occurred. For instance, when an item is requisitioned through the SBSS, it is assigned an AOA (CONUS) or an AO1 (Overseas) code for auditing purposes. However, the original data set includes over 768 shipments and only 94 shipments are assigned AO codes, approximately 15 percent of the total shipments. The 63 randomly selected shipments (DD Forms 1348-1A received) are evaluated through the use of the ETADS data and compared with the actual DD

Forms 1348-1A to identify the AO (requisition) date. The data show there are no shipments that exceed the UMMIPS standard for the AO portion of the pipeline. Therefore, the data support the conclusion that no bottlenecks exist within this segment of the logistics reparable pipeline.

The identification of bottlenecks within the AE segment results from the same method of evaluation that is performed on the AO segment. The data in Figure 6 below indicate that approximately 60 percent of the shipments are the result of a backorder as the primary cause of the bottleneck.

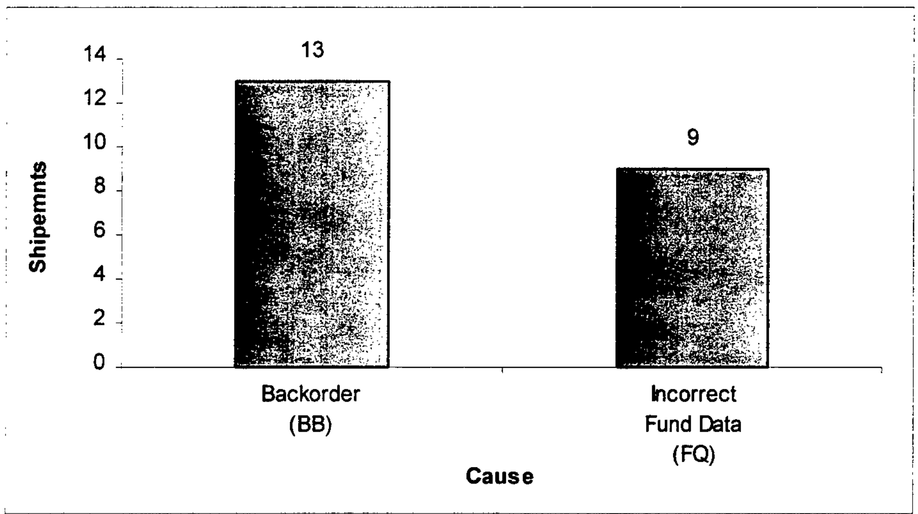

Figure 6. AE Bottleneck Causes

This evaluation led to the identification of 22 shipments that exceeded the authorized UMMIPS standard of one day. Therefore, bottlenecks are evident within this segment. A more in-depth inspection, which includes critical evaluation of each shipment that exceeds the UMMIPS standard, shows that a majority of the delays in the determination of availability are caused by a inadequate supply of parts. Thirteen of the 22 shipments were backordered (BB) and an additional nine shipment delays were the result of parts being backordered due to a new funding code requirement (FQ).

With regard to the shipment status, AS, of the 63 shipments listed above, the bottleneck identification process is performed in the same manner as the other previous pipeline segments. The data explicitly identifies 49 shipments exceeding the UMMIPS standard of one day for CONUS intransit and five days for Overseas intransit. Also, by evaluating actual shipping documents (DD Form 1348-1A, Airway Bills, Government Bills of Lading), the data show that 27 shipments were shipped over a weekend and 19 shipments were sent second-day air because FedEx, the government contract carrier, does not offer Saturday delivery for cargo weighing more than 150 pounds. The remaining eight of the 27 weekend shipments could have been delivered on Saturday; however, the transportation office would have to pay a higher premium for this service. The remaining 22 shipments were shipped on either Monday, Tuesday, or Wednesday, with an average intransit time of 25 days

The actual shipping documents and data retrieved from the Visual Logistics Information Processing System (VLIPS) show that some of the parts being shipped under a different transportation priority than is stated on the shipping document. For example, shipment FB483062330270 is shown as a TP2 when it should be a TP1/NMCS. Another cause for the excessive intransit time is due to the shipment traveling under Mode B, less than truckload, which takes between seven to 10 days for delivery to the customer. Sending an NMCS item by any mode other than next day air, regardless of cost, will result in a shipment exceeding the UMMIPS standard for the CONUS portion of the intransit shipment.

The D6 receipt segment of the bottleneck is evaluated in the same manner as the AO, AE, and AS segments of the pipeline. The shipping documents as well as the data show that eight of the 63 shipments were actually received prior to the date listed in ETADS. These shipments were probably received by a base supply representative and the document was batch processed.

Our research found that six of the 63 DD Forms 1348-1A received, approximately 10 percent, identified actual signed base supply receipt dates by the consignee that were several days earlier than the receipt dates reported by ETADS. The ETADS data is only as accurate as the information entered into the system. The reduction in dates leads to the conclusion that upon receipt by base supply, the receiving customer's unit is notified and a representative picks up the item or supply delivers the item to the unit. After the customer signs for an item, the accompanying shipment document, the DD Form 1348-1A, is batch processed several days later into the computer system.

The batch processing of documents is more likely to occur when a Saturday and Sunday are within one day of the date of actual receipt of the item. This is because these days are not normally duty days. The misrepresentation of actual receipt dates has led to many conversations between commanders and senior ranking officers concerning their mission readiness standards.

Six of the 63 shipments, approximately 10 percent, were received an average of five days prior to being processed into the SBSS. This information was taken directly from each DD Form 1348-1A which is an actual receipt document. The receipt information for the 29 shipments above, which were received earlier than the ETADS receipt date, was gathered from an ETADS computer product. The actual receipts are more accurate. Shipment receipt dates entered into the SBSS using a batch process results in an inaccurate reporting of actual receipt dates; therefore, this leads to a misrepresentation of the true performance of the logistics reparable pipeline.

It is standard procedure at some supply squadrons to hold documents with routine priorities and use a batch entry process in order to save time and money. This savings occurs through the reduction in the amount of time it takes an employee to walk from the receipt location to the SBSS computer and actual time for inputting the document. Batch processing allows one person to enter multiple documents into the computer system during a single session rather than multiple sessions. A reduction in time results in a reduction in man-hours thus a cost reduction would result. Even though these employees are federal employees or military members, a reduction in the process time could eventually result in less required manpower to perform that specific function. Batch processing is an effective and efficient method of reducing the time it takes a person to input data. For example, in a depot repair facility, less overall setup time is needed to repair a batch of 20 brake assemblies than it would to setup each brake assembly one by one, especially when the machine can be used to repair brakes for multiple weapons systems. If it requires 30 minutes to setup the brake repair machine with the proper tools, 20 separate brake assemblies would require 10 hours of setup time. A batch setup for 20 brake assemblies would save nine and one-half hours in setup time. This example is clear enough and represents a fairly common situation. However, this study is concerned with NMCS parts and these parts can not afford the extra hold time at the depot repair facility awaiting a full batch to begin work. NMCS parts must be repaired immediately upon receipt to ensure the expedient return to the customer and to ensure aircraft mission capability at the earliest possible moment.

It is not an accepted policy to batch process MICAP/NMCS documents due to their critical nature and high visibility. Inaccurate receipt dates reflect poorly in terms of shipper's performance in comparison to the UMMIPS standard. This places the responsibility on the shipper to justify why certain aircraft parts were not received on-time. This situation can be avoided by annotating the actual receipt date on every DD Form 1348-1A as each item is received and then making a timely entry into the SBSS.

Research Question 2. How can the bottlenecks be reduced or eliminated?

Knowing and admitting that bottlenecks exist and where they occur within the pipeline is the first major step to improving the process. The next major step is to suggest ways to reduce or eliminate these bottlenecks. It is assumed that if any of these suggestions are implemented, the result could be a reduction in overall pipeline resupply time of at least one day, equating to a savings of approximately $25.45 million (Hill et al, 1990:iii). This is the goal of this thesis.

It would seem apparent, since the allowed CONUS transit time is one day, that all MICAP/NMCS parts should be shipped overnight express by companies such as FedEx, Emery Worldwide, UPS, or other expedited cargo movement specialists. Furthermore, since these parts are such a high priority, the government should pay the higher costs associated with next-day air delivery or Saturday delivery versus a two-day delivery which costs less but arrives only one day later. The two-day delivery does not meet the UMMIPS standard, but it meets the customer's needs in a timely manner and it will save the Air Force money. For example, shipments with a gross weight greater than 150 pounds, FedEx charges $224.25 for next-day delivery and $171.60 for two-day delivery (General Services Administration, 1996:12). The practical decision the customer must make is whether the part is needed in one day or can wait one additional day for delivery and still repair the aircraft before its next scheduled mission. It is assumed the part is required for an aircraft that is not fully mission capable (FMC). Therefore, the part needs to be received as soon as possible to ensure that aircraft maintenance can repair the aircraft and upgrade its status to FMC. The increased costs for next-day delivery versus two-day delivery, used in the earlier example, is insignificant when the amount of fixed and variable costs associated with repairing a NMCS aircraft are considered.

Improve planning, performance, and mission readiness by sending all NMCS shipments via overnight express delivery. If funding is not available, or if the customer can accommodate a one day delay, then ship parts using second day air or two-day guaranteed LTL service. Shipments should only be tendered to a trucking company for LTL movement if the carrier uses electronic data interchange (EDI) and guarantees the delivery. If these recommendations are implemented, the number of shipment delays could greatly diminish.

Concerning the bottlenecks within the availability, AE, segment of the pipeline, it is recommended to increase the levels of supply on-hand to prevent backorders by ensuring contractors repair unserviceable items in a timely manner. If backorders can be prevented, the entire process speed could increase and lead to more timely repairs for NFMC aircraft. If a contractor can reduce its repair cycle by one day, this could result in an item available one day earlier than normal thus reducing the length of the pipeline by the same amount of time. A benefit is that each part within that particular process being installed one day earlier into a broken aircraft and helping to upgrade the aircraft's status to FMC.

The external paperwork problem concerning document batch processing can be resolved through the implementation of a new procedure. If all supply organizations adopt a policy of inputting receipt information into the SBSS on the date when receipt occurs, the inaccuracy of the ETADS receipt date would be resolved. As stated previously, batch processing will save an organization time and money (labor costs). However, NMCS parts are the most time sensitive shipments in the Air Force. The priority and high visibility given to these parts by all parties within the logistics reparable pipeline require these parts to be input into the SBSS upon receipt.

This procedure would eliminate any ambiguity or misrepresentation concerning the receipt date within the various data systems. The batch processing could cause commanders in the field to be improperly briefed concerning the UMMIPS performance of these critical NMCS parts. When properly researched, the problem area, as related to the specific parts, may not turn out to be the problem area. For instance, if parts take 10 days within CONUS to be received from date of requisition, the most likely segment within the pipeline causing shipment delays is transportation. Forty-nine of the 63 shipments experienced shipment delay due to transportation. and 18 of the shipments had bottlenecks occurring within the item availability segment of the pipeline.

Document batch processing is probably the easiest problem to correct amongst the problems areas listed within this study. Bottlenecks are much harder to eliminate or reduce than to implement a change in policy. Batch processing is the result of policy. Correcting batch processing problems is a free-fix because the problem can be resolved without the need for additional funding.

There are several potential solutions to correct the batch processing problem. The first proposed solution is to implement a policy that requires the receipt of all shipments to be immediately implemented into the SBSS. This action should prevent inaccurate data reporting and enhance the decision-making process of all agencies involved in the process. This includes all personnel currently using the SBSS and ETADS data systems. Another proposed solution is to implement use of an Electronic Data Interchange (EDI) system to input the NMCS shipments immediately upon receipt. Bar-code or optical scanners could fulfill this purpose.

The importance of accurately reporting data can not be underestimated. Incorrect dates of receipt could adversely affect the use of commercial freight carriers (air & motor). Incorrect shipment receipt information could improperly indicate a carrier's performance. If shipment receipt data indicate continually late deliveries to the destination, the Traffic Management Office may request a period of probation or non-use for that carrier. Therefore, the carrier will lose business due to inaccurately reported data.

The importance of the TOC is brought to light with the identification of the existence and location of bottlenecks. Identifying bottlenecks is the first step of the five step TOC process. As stated previously in Chapter 2, the implementation of the TOC process effectively reduced delivery lead time for Stanley Furniture Company. The company realized a series of reductions in delivery lead time by iteratively applying the five focusing steps to break three successive constraints: the first station of each assembly line, the order entry process, and the traffic shipping function (Chakravorty, 1996:226). The TOC could be applied to the logistics reparable pipeline bottlenecks and may result in reductions in transit time (delivery times).

The TOC is a continual improvement philosophy that focuses on the identification and management of constraints for organizational goal achievement. The TOC also focuses on the identification and management of the constraints. This study is concerned with the identification of bottlenecks (constraints). Once identified, constraints could be eliminated through process improvement. Translated, this means that if bottlenecks exist within the AE and AS segments, managers should be able to control the bottlenecks to prevent or reduce delays in the logistics pipeline. If it takes an average of 25 days to receive a part from the date of requisition, and this is a relatively consistent time period, then managers can adapt their schedules to meet the intransit time. However, with MICAP/NMCS shipments, managers do not have this luxury. They must receive parts as quickly as possible to ensure aircraft can be made mission capable at the earliest opportunity.

Summary

This chapter presented the results of the data analysis based on the methodology presented in Chapter Three. Each of the research questions was addressed along with the presentation of the necessary data. The data clearly indicate that bottlenecks exist Air Force wide within the logistics reparable pipeline. The segments of the pipeline where the most bottlenecks occur are the AE (item availability) and AS (shipment status). The data also reveal 18 shipments with multiple bottlenecks. The TOC was presented because of the potential for process improvement in the logistics reparable pipeline.

V. Conclusions and Recommendations

Chapter Overview

This chapter provides the conclusions drawn from this study based upon the data analysis and summarizes several recommendations for the possible elimination or reduction of bottlenecks in the logistics reparable pipeline as stated in the data analysis portion of this study. Next, the limitations of this study are presented and finally, suggestions for further research to continue the Air Force's reengineering efforts to improve the logistics system and reduce costs.

Conclusions

It is apparent that bottlenecks exist within the logistics reparable pipeline, based upon the supporting data from ETADS which show that 83.46 percent, of the 768 shipments evaluated, did not meet the UMMIPS standard. Furthermore, data show that bottlenecks exist Air Force wide. When divided by theater of operation, it is also concluded that bottlenecks exist within multiple segments in the pipeline. These segments are the AE (Item Availability) and AS (Shipment Status). The most prominent location is the AS segment with 49 shipments exceeding the UMMIPS standard by more than one day. Most of these shipment delays can be explained as a combination of a bottleneck and improper planning.

Recommendations

In order to offer potential solutions to existing bottlenecks, we must first identify the current bottlenecks and possible factors causing the bottlenecks. Based on careful evaluation of the processes, this study concludes that the factors affecting the bottlenecks are improper planning.

Improper planning is both a management and individual responsibility. The first step is to confirm the priority and accuracy of all information and documents associated with each part. The first document to verify is the DD Form 1348-1A because it is the key document for each part within the supply requisitioning process. It contains the crucial data for bottleneck evaluation. Each document has several specific locations that require signatures from individuals throughout the process to provide a shipment audit trail. When the part is a NMCS/MICAP, the item receipt time/date is required. These times/dates are used to evaluate the performance of the supply and transportation systems in regards to the UMMIPS standards.

It is crucial to verify the SRAN/DoDAAC of the destination organization. If this information is inaccurate it will most assuredly result in serious delays within the order-cycle and logistics pipeline. It will also result in increased transportation costs due to the item being sent to the wrong location. Finally, it could result in a serious degradation of the customer's unit mission effectiveness.

The key improper planning situations evidenced in this study were shipments of NMCS parts via transportation mode "B" (Less Than Truckload) and shipping over a weekend by a carrier that does not offer a Saturday delivery for parts weighing over 150 pounds. The first problem can be resolved easily.

The UMMIPS standards set forth a one day CONUS intransit period. The transportation office can ship NMCS parts by DoD cleared carriers such as Emery and FedEx at an increased price. By the same token, a second planning problem can be resolved by using a carrier that offers Saturday delivery for parts weighing over 150 pounds.

Limitations of the Study

The scope of this study only concerns five avionics LRUs for the F-16 weapons system. This study only evaluated NMCS parts; however, there are several other shipments priority categories. Another limitation is the lack of accurate requisition dates by the customers to offer valid starting points for the various evaluations performed in this study.

Suggestions for Further Research

Funding constraints and inadequate spare part inventory levels are also areas for future research. The amount of funding affect the level of spare parts availability. In the past several years, the Air Force has experienced dramatic budget reductions. The budget reduction resulted in fewer spare parts available which created back orders to fulfill the requirement. It is not sound management to consistently fill requirements with backorders because this only increases the length of the logistics reparable pipeline. It is recommended that research be conducted into ways of reducing the increasing number of back orders. As long as the budget constraints continue, less spare parts will be available for replacements. What price do you put on a unit failing to meet their mission due to a part unavailability or transportation delay?

The implementation of the DoD Logistics Strategic Plan, 1994 edition, was supposed to be finished in 1996. "According to DoD's current plan, the total asset visibility initiative will not be completely implemented until 2001. The lack of adequate visibility over operating materials and supplies substantially increases the risk that millions of dollars will be spent unnecessarily" (GAO3, 1997:16).

It is also suggested to research specific portions of the pipeline (AO, AE, AS, D6), to identify solutions to the recurring delays and problems associated with a particular segment as it relates to the logistics reparable pipeline. Another area for additional research is to perform a cost benefit analysis of shipping NMCS parts via the various transportation modes. Finally, perform an evaluation of the current UMMIPS standard to determine its applicability in today's budget constrained DoD.

<u>Appendix 1</u>

UMMIPS Time Standards in Calendar Days (Note 1)
<u>(Adapted from DoD 4140.1-R, DoD Materiel Management Regulation, 1993)</u>

	TP-1					TP-2					TP-3				
Priority Designator Edit Requirements	(PD 01-03)					(PD 04-08) (PD 01-15 for 444)					(PD 09-15)				
PIPELINE SEGMENT (Note 1)	**RDD OF 999,N__, E__**					**RDD OF 444,555,777**					**Blank RDD**				
A. Requisition Submission	1					1					2				
B. Passing Action	0.5					1					1				
C. ICP Availability Determination	1					1					1				(Note 3)
D. Depot Storage Site and/or Base Processing and Packaging	1					1					5				
E. Transportation Hold and CONUS Intransit	1					4					10				(Note 4)
Area (Note 2)	CONUS	1	2	3	4	CONUS	1	2	3	4	CONUS	1	2	3	4
F. POE and/or CCP Processing and Intransit to Carrier	N/A	1	1	1	3	N/A	1	1	1	3	N/A	10	10	10	21 (Note 4)
G. Intransit Overseas	N/A	1	1	2	3	N/A	1	1	2	3	N/A	10	15	25	30
H. POD Processing	N/A	1	1	1	1	N/A	1	1	1	2	N/A	3	3	3	5
I. Intra-theater Intransit	N/A	1	1	1	1	N/A	1	1	1	1	N/A	5	5	5	5
J. Receipt Take-up by Requisitioner	0.5	0.5	0.5	0.5	0.5	1	1	1	1	1	3	3	3	3	3
K. Total Order and Ship Time	5	9	9	10	13	9	13	13	14	18	22	50	55	65	83

NOTES
Required Delivery Date (RDD):
- -- 999 Indicates expedited handling requirements for non mission capable supply (NMCS) overseas or CONUS customers deploying overseas within 30 days
- -- N__ Indicates expedited handling due to NMCS requirement CONUS customer
- -- E__ Indicates expedited handling due to anticipated NMCS requirement CONUS customer
- -- 555 Indicates exception to mass requisition cancellation, expedited handling required
- -- 777 Indicates expedited handling required for other than the above reasons
- -- 444 Indicates handling service for customers collocated with the storage activity or for locally negotiated arrangements
- -- Specific date indicates handling to meet that date of delivery
- -- Blank RDD indicates routine handling

(1) Pipeline standards for materiel delivered exclude weekends and holidays except for segments D and E for requirements with RDDs 999, N__, or E___. Storage activity and transportation managers may combine the times for segments D and E as long as the combined time is not exceeded. The pipeline time standards are service level targets; they shall be met or improved upon whenever physically and economically feasible.

(2) Areas:
1. To Alaska (Elmendorf only), Hawaii, N. Atlantic, Caribbean, or Central America.
2. To U.K. and Northern Europe.
3. To Japan (Yokota only), Okinawa, Korea (Osan only), Philippines, Guam and Western Mediterranean.
4. To hard lift areas and all other destinations not included in 1-3 (e.g. S. America, Eastern Mediterranean, Africa, Diego Garcia, etc.) as determined by USTRANSCOM.

(3) For manually submitted requisitions or requisitions requiring manual review, 1 day for PDs 01-08 and 3 days for PDs 09-15.
(4) Combine segments E and F as a single segment when a SEAVAN is loaded at source or when cargo is moved breakbulk to
Measurement of intra/inter-service lateral support or redistribution begins at C or D (installation level).

Appendix 2

Shipment Analysis by Theater and Base

USAFE	9	11.95	2.95	3	0.14	18	0.86
CENTAF	13	15.10	2.10	1	0.04	27	0.96
PACAF	10	12.78	2.78	14	0.38	23	0.62
AAC	9	15.00	6	1	0.33	2	0.67
* UMMIPS Standard Varies by Theater							
SRAN/DoDAAC	**Base**	**UMMIPS Std**	**Mean Order Cycle Days**	**Mean Difference**	**# Shipments**	**% Shipments**	**# Shipments**
FB2027	Hill AFB, UT	5	10.19	5.19	10	**38.46**	16
FB2823	Eglin AFB, FL	5	9.05	4.05	3	20	12
FB4803	Shaw AFB, SC	5	15.33	10.33	0	0.00	9
FB4819	Tyndall AFB, FL	5	24.50	19.50	0	0.00	2
FB4830	Moody AFB, GA	5	14.55	9.55	1	3.4483	28
FB4852	Nellis AFB, NV	5	18.24	13.24	6	17.65	28
FB4855	Cannon AFB, NM	5	17.03	12.03	7	11.29	55
FB4877	Davis-Monthan AFB, AZ	5	39.00	34.00	0	0.00	1
FB4887	Luke AFB, AZ	5	14.26	9.26	33	19.08	140
FB4897	Mountain Home AFB, ID	5	15.50	10.50	0	0.00	2
FB6012	Danelly ANG, AL	5	11.52	6.52	6	24.00	19
FB6022	Tucson ANG, AZ	5	7.00	2.00	9	69.23	4
FB6044	California ANG, Fresno, CA	5	8.67	3.67	3	50.00	3
FB6061	Buckley ANG, CO	5	12.05	7.05	5	26.32	14
FB6123	Springfield ANG, IL	5	15.57	10.57	0	0.00	14
FB6131	Terre Haute ANG, IN	5	13.18	8.18	4	18.18	18
FB6132	Fort Wayne ANG, IN	5	18.08	13.08	0	0.00	13
FB6141	Des Moines ANG, IA	5	11.50	6.50	0	0.00	3
FB6142	Sioux City ANG, IA	5	14.14	9.14	0	0.00	7
FB6221	Selfridge ANGB, MI	5	15.00	10.00	0	0.00	2
FB6303	NJ ANG, Egg Harbor TWP, NJ	5	8.50	3.50	3	50.00	3
FB6311	NM ANG Kirtland AFB, NM	5	13.18	8.18	3	17.65	14
FB6324	Syracuse ANG, NY	5	15.29	10.29	1	7.14	13
FB6352	Springfield ANG, OH	5	13.14	8.14	3	14.29	18
FB6355	Toledo ANG, OH	5	15.00	10.00	0	0.00	6
FB6401	SC ANG, McEntire ANGB, SC	5	15.33	10.33	0	0.00	3
FB6411	Sioux Falls ANG, SD	5	13.36	8.36	2	18.18	9
FB6432	Texas ANG, Kelly AFB, TX	5	22.00	17.00	0	0.00	7
FB6451	Burlington ANG, VT	5	11.18	6.18	4	23.53	13
FB6461	Byrd Field, VA	5	8.93	3.93	7	50.00	7
FB6492	Madison ANG, WI	5	16.90	11.90	2	20.00	8
FB6511	Andrews ANG, DC	5	11.40	6.40	6	30.00	14
FB6563	Tulsa ANG, OK	5	16.60	11.60	1	10.00	9
FB6648	Homestead AFB Reserve, FL	5	11.68	6.68	4	21.05	15
FB6675	Carswell AFB Reserve, TX	5	11.82	6.82	3	27.27	8
FB6716	New Orleans ANG, LA	5	15.00	10.00	2	22.22	7
Total			**14.55**	**9.55**	**128**	**16.92**	**544**
FB5000	Elmendorf AFB, AK	9	1.00	-8.00	1	100.00	0
FB5004	Eielson AFB AK	9	15.00	6.00	0	0.00	2
FB5411	Incirlik AB, TU	9	16.50	7.50	0	0.00	2
FB5486	52 FW Deployed, Aviano AB, IT	9	24.00	15.00	0	0.00	1
FB5621	Spangdahlem AB, GE	9	12.00	3.00	3	33.33	6
FB5682	Aviano AB, IT	9	16.33	7.33	0	0.00	9
Total			**14.14**	**5.14**	**4**	**22.22**	**20**
FB5205	Yokota AB, JA	10	15.00	5.00	0	0.00	3
FB5284	Kunsan AB, ROK	10	6.00	-4.00	6	75.00	2
FB5294	Osan AB, ROK	10	14.30	4.30	3	15.79	16
Total			**11.77**	**1.77**	**9**	**30.26**	**21**
FB4823	Dhahran AB, KSA	13	15.29	2.29	1	3.57	27
Total			**15.29**	**-1.71**	**1**	**3.57**	**27**

Appendix 3

Randomly Selected Shipments (100)

Random #		TCN/Document Number	Base	Date Req	Date Recd	Order Cycle Time	Date Recd	DD Form 1348-1A Data Date Processed as Recd	Difference	True Performance
94	AE1	FB202761969819	Hill AFB, UT	6196	6212	16	6212	6212	0	16
119	AE2	FB282361849086	Eglin AFB, FL	6184	6199	15				0
120	AE2	FB282361851080		6185	6199	14				0
124	AE2	FB282362120040		6212	6227	15				0
133	AE1	FB282362569111		6256	6257	1	6261	6261	0	5
134	AE2	FB282362570248		6257	6272	15				0
136	AE2	FB480361849001	Shaw AFB,SC	6184	6199	15	6187	6187	0	3
137	AE2	FB480361849020		6184	6199	15	6187	6187	0	3
142	AE2	FB480362159009		6215	6230	15	6218	6218	0	3
21	AE1	FB48236223B007	Dhahran AB, Saudi Arabia	6223	6233	10				0
27	AE2	FB482362450111		6245	6261	16				0
151	AE2	FB483061769026		6176	6192	16				0
167	AE2	FB483062330270		6233	6248	15				0
172	AE2	FB483062439032		6243	6258	15				0
187	AE2	FB485262001072	Nellis AFB, NV	6200	6215	15				0
198	AE2	FB485262320265		6232	6247	15				0
199	AE2	FB485262320270		6232	6247	15				0
201	AE2	FB485262439001		6243	6258	15	6247	6253	6	4
211	AE2	FB485262569003		6256	6271	15	6260	6261	1	4
219	AE2	FB485561730650	Cannon AFB, NM	6173	6191	18	6190	6190	0	17
220	AE2	FB485561770269		6177	6192	15				0
222	AE2	FB485561789003		6178	6194	16				0
227	AE2	FB485561910172		6191	6206	15	6193	6193	0	2
230	AE2	FB485561979001		6197	6212	15				0
232	AE2	FB485561989010		6198	6214	16	6220	6220	0	22
249	AE2	FB485562199003		6219	6233	14				0
250	AE2	FB485562259003		6225	6243	18	6233	6233	0	8
253	AE1	FB485562270641		6227	6232	5	6244	6244	0	17
256	AE2	FB485562299001		6229	6244	15	6235	6235	0	6
265	AE2	FB485562420251		6242	6257	15	6249	6249	0	7
326	AE1	FB488762009015	Luke AFB, AZ	6200	6209	9	6219	6219	0	19
333	AE2	FB488762050687		6205	6220	15				0
341	AE2	FB488762080588		6208	6223	15	6219	6219	0	11
350	AE1	FB488762139003		6213	6218	5	6218	6223	5	5
352	AE2	FB488762139021		6213	6228	15	6214	6214	0	1
360	AE2	FB488762190049		6219	6233	14	6223	6223	0	4
367	AE2	FB488762210809		6221	6237	16	6214	6214	0	-7
378	AE2	FB488762260556		6226	6241	15				0
387	AE1	FB488762299029		6229	6240	11	6243	6243	0	14
390	AE1	FB488762339046		6233	6235	2	6235	6235	0	2
395	AE1	FB488762349069		6234	6244	10	6243	6243	0	9
397	AE2	FB488762350278		6235	6250	15	6235	6235	0	0
399	AE2	FB488762350377		6235	6250	15	6243	6243	0	8
401	AE2	FB488762359056		6235	6251	16	6240	6240	0	5
409	AE1	FB488762369022		6236	6246	10	6248	6248	0	12
414	AE1	FB488762419025		6241	6245	4	6240	6240	0	-1
421	AE1	FB488762449019		6244	6248	4	6248	6250	2	4
427	AE2	FB488762499041		6249	6264	15	6249	6249	0	0
439	AE2	FB488762570391		6257	6272	15	6250	6250	0	-7
444	AE1	FB488762599041		6259	6271	12	6264	6274	10	5

Randomly Selected Shipments (100)

								DD Form 1348-1A Data		
Random #		TCN/Document Number	Base	Date Req	Date Recd	Order Cycle Time	Date Recd	Date Processed as Recd	Difference	True Performance
452	AE2	FB488762670255	Luke AFB, AZ	6267	6282	15				0
461	AE2	FB488762710068		6271	6286	15	6274	6274	0	3
43	AE1	FB528462629601	Kunsan AB, Korea	6262	6262	0				0
50	AE1	FB529462060070	Osan AB, Korea	6206	6220	14				0
51	AE2	FB529462060391		6206	6221	15				0
86	AE2	FB568262500180	Aviano AB, Italy	6250	6265	15				0
475	AE1	FB601262010129	Danelly ANG, AL	6201	6206	5				0
488	AE2	FB601262630612		6263	6278	15				0
494	AE1	FB602262157681	Tucson ANG,AZ	6215	6218	3	6227	6227	0	12
498	AE2	FB602262639850		6263	6278	15	6270	6270	0	7
505	A0A	FB606161730250	Buckley ANG, CO	6173	193	20	6189	6189	0	16
510	A0A	FB606162010167		6201	212	11	6212	6212	0	11
515	AE1	FB606162299711		6229	6235	6	6240	6240	0	11
519	AE1	FB606162489701		6248	6251	3	6263	6263	0	15
525	AE2	FB606162620068		6262	6277	15	6277	6277	0	15
527	AE2	FB612361770166	Springfield ANG, IL	6177	6192	15				0
539	AE2	FB613161859851	Terre Haute ANG, IN	6185	6200	15	6192	6192	0	7
540	AE2	FB613161919801		6191	6206	15	6190	6190	0	-1
542	AE1	FB613162071697		6207	6234	27	6236	6236	0	29
555	AE2	FB613162420356		6242	6257	15				0
567	AE2	FB613262130103	Fort Wayne ANG, IN	6213	6228	15	6214	6214	0	1
579	AE1	FB614262249400	Sioux City ANG, IA	6224	6232	8				0
581	AE2	FB614262279402		6227	6242	15				0
609	AE1	FB631162200339	NM ANG Kirtland AFB, NM	6220	6222	2	6225	6225	0	5
610	AE2	FB631162210146		6221	6236	15				0
616	A0A	FB632461940204	Syracuse ANG, NY	6194	212	18	6225	6225	0	31
619	AE2	FB632462139110		6213	6228	15				0
624	AE2	FB632462360348		6236	6251	15				0
625	AE1	FB632462410025		6241	6257	16				0
634	AE2	FB635261930074	Springfield ANG, OH	6193	6208	15				0
647	AE2	FB635262419601		6241	6257	16	6242	6248	6	1
650	AE2	FB635561800279	Toledo ANG, OH	6180	6195	15				0
660	AE1	FB641161919426	Sioux Falls ANG, SD	6191	6193	2	6193	6193	0	2
670	AE2	FB641162560111		6256	6271	15				0
687	AE1	FB645162060051	Burlington ANG, VT	6206	6210	4	6222	6222	0	16
699	AE1	FB646162140530	Byrd Field, VA	6214	6235	21	6240	6240	0	26
702	AE2	FB646162260391		6226	6241	15				0
708	AE2	FB646162620292		6262	6277	15				0
710	AE1	FB646162680352		6268	6268	0				0
714	AE1	FB649262320360	Madison ANG, WI	6232	6233	1				0
732	AE1	FB651162130283	Andrews ANG, DC	6213	6234	21				0
736	AE2	FB651162310023		6231	6247	16				0
741	AE1	FB656362280372	Tulsa ANG, OK	6228	6237	9				0
747	A0A	FB664862130072	UNKNOWN	6213	222	9				0
750	AE1	FB667561940070	Carswell AFB Reserve, TX	6194	6197	3	6200	6200	0	6
751	A0A	FB667561940070		6194	200	6				0
757	AE1	FB667562220204		6222	6227	5	6229	6229	0	7
762	AE2	FB671661709641	New Orleans ANG, LA	6170	6185	15				0
766	AE2	FB671662120032		6212	6227	15				0
768	AE2	FB671662550280		6255	6270	15				0

Appendix 4

Randomly Selected Shipments Accompanied with Shipping Documents (63 of 100)

Document Number	Location	(AO) Requisition	(AE) Availability	(AS) Shipment Status	(D6) Receipt
FB202761969819	Hill AFB, UT	6196	6212	6212	6212
FB282362569111	Eglin AFB, FL	6256	6257	6258	6261
FB480361849001	Shaw AFB,SC	6184	6184	6184	6187
FB480361849020		6184	6184	6184	6187
FB480362159009		6215	6215	6215	6218
FB48236223B007	Dhahran AB, Saudi Arabia	6223	6223	6233	6256
FB482362450111		6245	6246	6251	6263
FB483061769026	Moody AFB, GA	6176	6177	6177	6201
FB483062330270		6233	6233	6233	6240
FB483062439032		6243	6243	6243	6247
FB485262439001	Nellis AFB, NV	6243	6243	6243	6247
FB485262569003		6256	6256	6256	6260
FB485561730650	Cannon AFB, NM	6173	6176	6176	6190
FB485561910172		6191	6191	6191	6193
FB485561989010		6198	6199	6199	6220
FB485562259003		6225	6228	6228	6233
FB485562270641		6227	6228	6234	6234
FB485562299001		6229	6229	6229	6235
FB485562420251		6242	6242	6242	6249
FB488762009015	Luke AFB, AZ	6200	6206	6211	6219
FB488762080588		6208	6208	6208	6213
FB488762139003		6213	6218	6219	6220
FB488762139021		6213	6213	6213	6214
FB488762190049		6219	6219	6219	6223
FB488762210809		6221	6222	6222	6232
FB488762299029		6229	6240	6242	6243
FB488762339046		6233	6233	6234	6235
FB488762349069		6234	6242	6248	6249
FB488762350278		6235	6235	6235	6239
FB488762350377		6235	6235	6235	6243
FB488762359056		6235	6236	6236	6240
FB488762369022		6236	6243	6246	6248
FB488762419025		6241	6250	6256	6264
FB488762499041		6249	6249	6249	6249
FB488762449019		6244	6247	6247	6248
FB488762570391		6257	6257	6257	6262
FB488762599041		6259	6271	6272	6274
FB488762710068		6271	6271	6271	6274
FB528462629601	Kunsan AB, Korea	6262	6263	6263	6267
FB529462060070	Osan AB, Korea	6206	6221	6221	6236
FB529462060391		6206	6206	6206	6222
FB568262500180	Aviano AB, Italy	6250	6250	6254	6262
FB602262157681	Tucson ANG,AZ	6215	6218	6222	6227
FB602262639850		6263	6264	6264	6270
FB606161730250	Buckley ANG, CO	6173	6178	6180	6189
FB606162010167		6201	6207	6208	6212
FB606162299711		6229	6235	6236	6240
FB606162489701		6248	6249	6253	6263
FB606162620068		6262	6262	6263	6268
FB613161859851	Terre Haute ANG, IN	6185	6185	6185	6192
FB613161919801		6191	6191	6191	6192
FB613162071697		6207	6234	6234	6236
FB613262130103	Fort Wayne ANG, IN	6213	6213	6213	6214
FB631162200339	NMANG Kirtland AFB, NM	6220	6222	6222	6225
FB632461940204	Syracuse ANG, NY	6194	6194	6207	6212
FB635262419601		6241	6241	6241	6242
FB641161919426	Great Falls ANG, MT	6191	6193	6193	6198
FB641162560111		6256	6256	6256	6260
FB645162060051	Burlington ANG, VT	6206	6206	6229	6232
FB646162140530	Byrd Field, VA	6214	6235	6236	6240
FB646162260391		6226	6226	6226	6229
FB667561940070	Carswell AFB Reserve, TX	6194	6197	6198	6200
FB667562220204		6222	6226	6228	6229

Bibliography

AFDD 40. Logistics. HQ USAF/XOX, 11 May 1994.

AFIT, Military Logistics Chapter Seven: The Retail/Wholesale Supply System, May 1990.

Air Force Materiel Command, Lean Logistics Program Office: PACER LEAN Program Management Plan. 1 May 1996, Version 1.0.

Air Force Materiel Command, Field Level Materiel Course: The AFMC Repair Enhancement Programs: Improvement in Progress. 10 Apr 1997.

Blanchard, Benjamin S. Logistics Engineering and Management, Fourth Edition. Englewood Cliffs NJ: Prentice Hall, 1992.

Chakravorty, Satya S. and Penelope R. Verhoeven. Learning the Theory of Constraints With a Simulation Game. Simulation & Gaming, Vol. 27, No. 2, June 1996.

Elliott, Russell S., Benedict C. Roberts and Sara P. Rudd. A DLA Study on the Costs of Reducing Depot Processing and Transportation Time. Department of Defense Logistics Agency Project Number DLA-95-P50017. September 1995.

Ely, Robert. "Speed Replaces Size in Lean Logistics' Approach to Inventories". Air Force News Service. WWWeb. http://www.af.mil:80/news/Apr1996/n19960411_960336.html.

General Accounting Office. Defense Depot Maintenance: Uncertainties and Challenges DOD Faces in Restructuring its Depot Maintenance Program. Report Number NSIAD-97-111. Washington: Government Printing Office, March 1997.

General Accounting Office. Defense Inventory: Spare and Repair Parts Inventory Costs can Be Reduced. Report Number NSIAD-97-47. Washington: Government Printing Office, January 1997.

General Accounting Office. Defense Inventory Management. Report Number HR-97-5. Washington: Government Printing Office, February 1997.

General Accounting Office. Defense Logistics: Much of the Inventory Exceeds Current Needs. Report Number NSIAD 97-71. Washington: Government Printing Office, February 1997.

General Services Administration. FedEx U.S. Government Contract Services Guide. August 1996.

Goldratt, Eliyahu M. The Goal: A Process of Ongoing Improvement. Second Edition. North River Press, Inc. 1992.

Gorman, Kevin. E-mail Correspondence. FedEx, Memphis TN. 9 June 1997.

Hill, John, Frederick Rexroad, and Captain Roger Moulder. Effects of Changes in Order and Ship Times and Depot Repair Cycle Times on Aircraft Availability and Procurement Costs. Headquarters, Air Force Logistics Command, Wright-Patterson AFB OH. XPS Technical Report #89-348, July 1990.

Joint Pub 4-0. Joint Logistics Doctrine, Joint Doctrine Capstone and Keystone Primer, 25 May 1995.

Lieb, Robert C. Transportation, Fourth Edition. Houston TX: Dame Publications Inc., 1994.

Russell, Dr. Stephen Hays. "Military Logistics and Business Logistics: Reexamining the Dichotomy," Air Force Journal of Logistics: 32-35 (Winter 1994).

Silver, Edward A. Decision Systems for Inventory Management and Production Planning. John Wiley & Sons: New York: 1985.

Tersine, Richard J. Principles of Inventory and Materials Management. Fourth Edition. Englewood Cliffs NJ: Prentice Hall, 1994.

Tucker, MSgt Scott. F-16 Two Level Maintenance (2LM) LEAN Logistics Manager, Hill AFB UT. Telephone interview, 13 December 1996.

Woolf, Henry B., Editor in Chief. Webster's New Collegiate Dictionary. G. & C. Merriam Company: Massachusetts, 1974.

Vita

Captain Karl N. Muno [redacted] graduated from Mundelein High School in June. 1981 and enlisted, with his parents permission, in the Air Force on July 1, 1981. His first assignment was with the 8th Transportation Squadron, Kunsan AB, Republic of Korea, as a Freight Traffic Specialist. His succeeding assignments as an enlisted member were at K.I. Sawyer AFB, MI, RAF Alconbury, United Kingdom, and Kirtland AFB, NM. While at Kirtland AFB, he attended Southern Illinois University where he earned a Bachelor of Science Degree in Vocational Education Studies in August. 1990. He earned his commission upon graduation from Officer Training School on July 29, 1992. His first assignment as a Transportation Officer was with the 438th Aerial Port Squadron, McGuire AFB, NJ, where he performed duties as an Air Terminal Operations Center Duty Officer. His next assignment was to the 355th Transportation Squadron at Davis Monthan AFB, AZ, where he was a Vehicle Operations and Combat Readiness Officer. He entered the Graduate School of Logistics and Acquisition Management, Air Force Institute of Technology, in May, 1996 and received a Masters Degree in Transportation Management on September 16, 1997. His follow-on assignment is to the 345th Training Squadron, Lackland AFB, TX, where he will perform duties as an instructor for the Transportation Officer Course.

[redacted]

Vita

Captain Patrick (Rick) K. Pezoulas [redacted] graduated from Coral Springs High School, Coral Springs, FL. in 1980 and enlisted in the Air Force in March 1983. His career as a transporter began with his first assignment as a packing and crating specialist with the 96th Transportation Squadron, Dyess AFB, TX. While stationed in Abilene, he attended McMurry University and received a Bachelor of Arts Degree in Business Management in March 1987. He earned his commission upon graduation from Officer Training School on 10 Aug 1989. He completed assignments to Dover AFB, DE, Yokota AB, Japan, Sembach AB, Germany, and Kadena AB, Japan, where he served in a variety of challenging positions as a Transportation Officer. He graduated with a Masters Degree in Transportation Management from the Graduate School of Logistics and Acquisition Management, Air Force Institute of Technology, Wright-Patterson AFB, OH, September 16, 1996, and received a follow-on assignment to the Headquarters Air Force Logistics Management Agency, Transportation Directorate, Gunter Annex, Maxwell Air Force Base, AL.

[redacted]

[redacted]

REPORT DOCUMENTATION PAGE		Form Approved OMB No. 074-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 1997	Master's Thesis

4. TITLE AND SUBTITLE
IDENTIFICATION AND REDUCTION OF BOTTLENECKS CONCERNING MICAP RE-SUPPLY OF F-16 WEAPONS SYSTEM AVIONICS LINE REPLACEABLE UNITS

5. FUNDING NUMBERS

6. AUTHOR(S)
Karl N. Muno, Captain, USAF
Patrick K. Pezoulas, Captain, USAF

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(S)
Air Force Institute of Technology
2950 P Street
WPAFB OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GTM/LAL/97S-6

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Headquarters Air Force Materiel Command/ LGTR
Wright-Patterson AFB, OH 45433

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 Words*)
This thesis evaluates selected F-16 avionics Line Replaceable Units (LRUs) transiting the logistics pipeline in order to examine the existence of bottlenecks and explore potential solutions within the current Department of Defense (DoD) logistics reparable pipeline. A previous study reported that a reduction in the overall pipeline resupply time of at least one day equates to a savings of approximately $25.45 million (Hill et al, 1990:iii). Bottlenecks cause movement delays to the entities moving through the logistics reparable pipeline. The pipeline segments are: AO (requisition), AE (item availability), AS (shipment status), and D6 (receipt). The bottlenecks of concern are those that occur when normally allowed transit times are exceeded.

The transit times are set forth by supply and transportation priorities in the Uniformed Materiel Movement and Issue Priority System (UMMIPS). This study focuses on five specific NMCS avionics Line Replaceable Units (LRU) which are also two level maintenance (2LM) parts for the F-16 weapons system. The data, retrieved from the Enhanced Transportation Automated Data System (ETADS), consists of 682 Air Force shipments from the period 1 July through 31 September 1996. The overall performance of the shipments was poor with approximately 83 percent failing to meet the authorized UMMIPS standard. The segment with the most bottlenecks is the AS (shipping status) segment. Of the 63 shipments evaluated (accompanied with shipping documents), 49 contained bottlenecks within the AS segment.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Logistics Pipeline, Pipeline Segment, F-16 Avionics, Line Replaceable Unit, LRU, Bottleneck	67
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

AFIT Control Number AFIT/GTM/LAL/97S-6

AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. **Please return completed questionnaire** to: AIR FORCE INSTITUTE OF TECHNOLOGY/LAC, 2950 P STREET, WRIGHT-PATTERSON AFB OH 45433-7765. Your response is **important**. Thank you.

1. Did this research contribute to a current research project? a. Yes b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

a. Yes b. No

3. **Please estimate** what this research would have cost in terms of manpower and dollars if it had been accomplished under contract or if it had been done in-house.

Man Years___________ $___________

4. Whether or not you were able to establish an equivalent value for this research (in Question 3), what is your estimate of its significance?

a. Highly Significant b. Significant c. Slightly Significant d. Of No Significance

5. Comments (Please feel free to use a separate sheet for more detailed answers and include it with this form):

_______________________________ Name and Grade

_______________________________ Organization

_______________________________ Position or Title

_______________________________ Address