

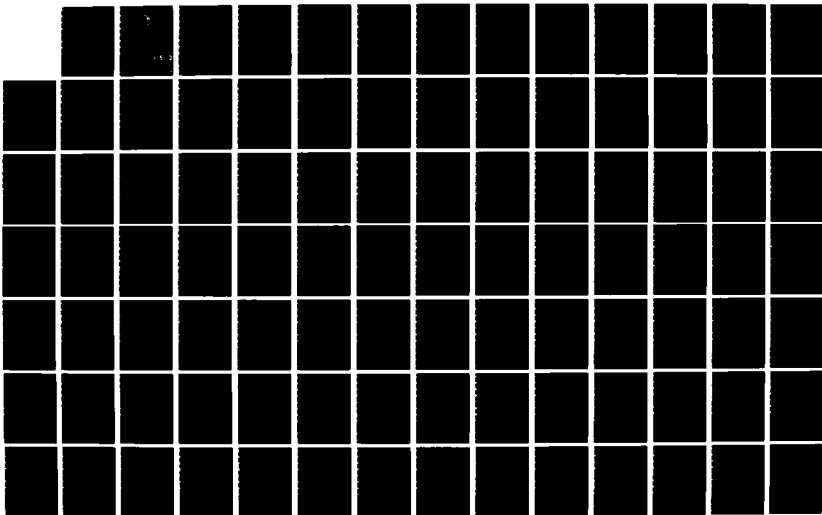
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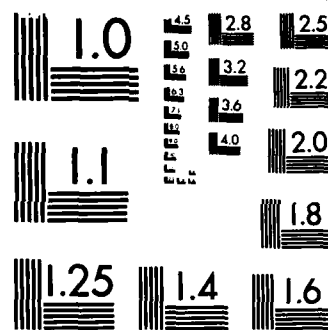
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ACQUISITION LOGISTICS CONSTRAINTS AND
RECOMMENDED SOLUTIONS: PERCEPTIONS OF
SENIOR DEPUTY PROGRAM MANAGERS
FOR LOGISTICS

THESIS

Robert F. Bayless
Lieutenant Colonel, USAF

AFIT/GLM/LSM/85S-4

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ACQUISITION LOGISTICS CONSTRAINTS AND
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SENIOR DEPUTY PROGRAM MANAGERS
FOR LOGISTICS

THESIS

Presented to the Faculty of the School of Systems and
Logistics of the Air Force Institute of Technology
Air University

In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Logistics Management

Robert F. Bayless
Lieutenant Colonel, USAF

September 1985

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Preface

This thesis could only be completed with the help and advice of many people.

A special thanks is due to all the Deputy Program Managers for Logistics and Directors of Logistics who generously volunteered their valuable time in interviews (some over four hours long) to provide their perceptions of what are the major acquisition logistic problems and how the Air Force could best resolve them. My opportunity to meet these dedicated and hard working professionals and share their perceptions was a very pleasurable experience. The value of this thesis is a reflection of their collective contributions.

I am also especially grateful to my advisor, Mr. Dyke McCarty, for his continual belief in this research effort and his helpful suggestions. I highly recommend, to any further researchers of this topic, the selection of Mr. McCarty for their advisor also. I am also thankful and indebted to Lt Col Joe Coleman, who kindly helped me through the statistics and computer programming obstacles involved with this research, and to Allene Mikrut, a loyal and supportive typist, for her outstanding service.

Last, but by no means least, I dedicate this thesis to my wife Sharon, who has always stood by me as my best friend. For this I am eternally grateful.

Table of Contents

	Page
Preface	ii
List of Figures	v
List of Tables	vi
Abstract	vii
I. Introduction	1
Problem Statement	1
Research Problem	2
Background	3
Research Objectives	8
Research Questions	9
II. Literature Review	10
Introduction	10
Definitions and Relationships	10
Initiatives in the Logistics Acquisition Environment	16
Baselining	18
Organizing for Logistics R&D	19
Grace Commission Initiatives	21
Reliability and Maintainability	22
Requirements Definition	23
Reliability and Maintainability Tasks ..	25
Test and Evaluation	27
RFP Evaluation Criteria	28
Incentives to Enhance R&M Initiatives ..	31
Trained Personnel	32
Measured Barriers to Implementing ILS	33
Review Conclusions	36
III. Research Methodology	38
Research Strategy	38
The Instrument	38
Instrument Pretest	43
Sample Selection	43
Subject Contact Plan	45
Conducting the Interview	46
Data Analysis	46

	Page
IV. Findings and Analysis	50
Introduction	50
Research Question One	51
Research Question Two	54
ASD/ESD Experienced DPMLs Compared	55
Junior/Senior Respondents Compared	56
Inexperienced/Experienced Respondents Compared	56
Time as a DPML Compared	58
Early/Late Acquisition Experience Compared	58
Research Question Three	58
Research Question Four	62
Requirements Definition	62
RFP Evaluation Criteria	66
Logistics R&D	68
Organizational Structure	70
DPML Authority	72
Trained Personnel	74
Test and Evaluation	82
Suggested Solutions to Respondent Generated Constraints	84
V. Conclusions and Recommendations	88
Research Question One	89
Research Question Two	90
Research Question Three	91
Research Question Four	92
Recommendations	93
Appendix A: Interview Form	94
Appendix B: Data Inputs From Respondents	99
Appendix C: SPSS Program Code	101
Appendix D: Sample Statistical Test For Evaluating Each Factor Between ASD and ESD	102
Appendix E: Sample Statistical Test For Evaluating... Each Demographic Category	104
Appendix F: Sample Statistical Test for Evaluating Each Factor By Experience Levels	106
Bibliography	107
Vita	110

List of Figures

Figure	Page
1. Relationship of Reliability to Life Cycle Cost ...	15

List of Tables

Table		Page
I.	Most Effective R&M Tasks as Perceived by AFSC R&M Workshop	25
II.	Proposed Barriers Ranked by Organization Mean Ratings	34
III.	Demographic Composition of Respondents	51
IV.	Proposed Constraints as Ranked by All DPMLs and DOLs	52
V.	Proposed Constraints as Ranked by the More Experienced DPMLs and DOLs	53
VI.	Comparative Rankings of All ASD and ESD Respondents	55
VII.	Comparison of Inexperienced and Experienced Respondents in Acquisition	57
VIII.	Suggested Solutions to Respondent Generated Constraints	85

Abstract

Over the last five years, significant actions have been taken by upper management levels to emphasize the importance of designing into new weapon systems a higher degree of reliability and maintainability. To further these efforts, research was needed to first, measure the significance of specific constraints impacting the "front line" initiators in the process, namely the Deputy Program Managers for Logistics (DPMLs), and second, to identify their recommended solutions to these constraints.

A literature review of what senior officials felt were problems in achieving R&M initiatives was developed into a list of seven acquisition logistics constraints. The list was then evaluated through personal interviews with the DPMLs and Directors of Logistics (DOLS) of the major programs within Aeronautical Systems Division (ASD) and Electronic Systems Division (ESD).

The respondents ranked the factors on a graphic rating scale and provided additional constraints they believed impacted their mission. Statistical tests showed a clear consensus by the respondents of the rank ordering of the seven constraints. In addition, there were no significant differences in the rankings by the two product divisions and few statistical differences between the respondents regardless of their rank or experience level.

To enhance the applied value of the research, the majority of the interview time was used collecting what the DPMLs perceived as the best solutions to these constraints. Their comments were candid and their 37 recommendations deserve further study, in that they were offered by the people who work closest to the logistics acquisition problems.

ACQUISITION LOGISTICS CONSTRAINTS AND RECOMMENDED
SOLUTIONS: PERCEPTIONS OF SENIOR DEPUTY PROGRAM MANAGERS
FOR LOGISTICS

I. Introduction

Problem Statement

In FY 84 the United States Air Force spent over \$20 billion in the acquisition of various weapon systems. Though a large sum of money, these acquisition costs on the average will be only 40% of each weapon system's total life cycle cost. Much of their large life cycle costs will be based on each system's design characteristics of reliability and maintainability (R&M). Therefore, the Department of Defense could save billions of dollars each year as well as improve total warfighting capability if systems were designed with a greater degree of reliability and maintainability. Because of these potential savings, numerous changes have been made in the last decade to try to improve the Defense Department's overall acquisition process.

After a long history of investigative reports and blue ribbon commissions, Deputy Secretary of Defense Frank Carlucci, who came into office in 1981, emphasized less studying of the problems and more implementing of solutions (5:57). One of his eight management principles stated:

Improved readiness is a primary objective of the acquisition process of comparable importance to reduced cost or reduced acquisition time. Resources to achieve readiness will receive the same emphasis as those required to achieve schedule or performance objectives. Include from the start of weapon system programs designed-in reliability, maintainability and support (18:1).

In order to do this, it is necessary for the Air Force to identify the major constraints of designing the optimum level of reliability, to determine their level of significance, and to develop methods to reduce the more significant constraints. The principal people responsible for initiating supportability considerations for a weapon system are the Deputy Program Managers for Logistics (DPMLs) and the Directors of Logistics (DOLs). Though there are differences in the scope of their responsibilities, references to DPMLs usually will encompass both DPMLs and DOLs. Working through a System Program Office (SPO), the DPML has various roles, but his/her primary one is influencing the program director and other staff agencies to place more emphasis on reliability and maintainability during the early phases of the acquisition cycle.

Research Problem

If the acquisition community can identify specific constraints impacting DPMLs, determine their significance, and evaluate various recommended solutions, a stronger negotiating capability for future DPMLs can be developed.

Research is necessary to accurately measure what the DPMLs perceive as the most significant constraints that affect their ability to influence design changes for supportability. In addition, the DPMLs' viewpoints of how these constraints should be resolved need to be consolidated and presented to decision makers.

Though numerous articles and theses have advocated stronger emphasis on supportability, none have specifically identified the factors constraining the DPMLs in the early phases or offered recommended solutions. Therefore, this research should be valuable not only to senior staff officers capable of making the necessary internal changes, but also to all those who work in acquisition logistics.

Background

Because of the substantial number of regulatory and organizational changes made in the last few years, it is important to review this trend of increasing emphasis in order to understand why articles written over four years ago are likely no longer to apply in evaluating the current situation.

The series of studies and regulations that changed acquisition logistics began in 1971 when DODD 5000.1 greatly improved the defining of the acquisition procedures (5:56). In 1972 the Congressionally directed Commission on Government Procurement (COGP) Report recommended numerous

changes to acquisition contracting procedures (24:19). In 1974 the Office of Federal Procurement Policy was established which centralized contracting efforts in the government. In 1976 OMB Circular A-109, incorporating many of the COGP recommendations, placed more emphasis on design concepts in terms of mission need and established clear lines of authority to Program Managers (24:19). In 1978 a Defense Science Board (DSB) Study, "Report of the Acquisition Cycle Task Force", made further recommendations which resulted in changes to DSARC reviews and required documents (5:57). In 1980, three regulations, DOD 5000.1, DOD 5000.2, and DOD 5000.39, all applied new emphasis to supportability in the early acquisition phases and made it an item of interest in Milestone reviews and funding decisions (39:5-6). In 1981 Deputy Secretary of Defense Frank Carlucci came into office. His extensive Acquisition Improvement Program, consisting of 32 initiatives, was later consolidated by Deputy Secretary of Defense Paul Thayer.

In addition to these regulatory changes and management issues, significant organizational changes were made that affected the Air Force acquisition environment. In 1976, the Air Force Acquisition Logistics Division (AFALD) was established at Wright-Patterson AFB under Air Force Logistics Command (AFLC). It was the first organization dedicated to encouraging decision makers to consider life

cycle costing (15:10). In 1977, the control of the deputy program managers for logistics shifted from the Air Logistics Centers to AFALD. AFALD then began placing the DPMLs in the Air Force Systems Command (AFSC) program offices in product divisions such as Aeronautical Systems Division (ASD) and Electronic Systems Division (ESD). These managers became the primary interfaces between AFLC and AFSC through their attempt to manage the integrated logistics support (ILS) elements in each new weapon system. In order to do this, the DPML received technical support from AFALD and from AFLC (28:6).

In 1978, AFLC established within its headquarters a single point of contact for acquisition programs and research needs (28:6). Then, in May 1981, the level of emphasis was further increased when Deputy Secretary of Defense Carlucci published the 32 initiatives to improve the acquisition process. Five Acquisition Improvement Program (AIP) actions addressed system support and readiness, funding for test hardware, contractor incentives for support, logistics and support resources, and improved reliability and maintainability. In July 1983, the new Deputy Secretary of Defense, Mr. Thayer, consolidated the list of 32 to 6 initiatives and support issues continued to receive heavy emphasis from top management (4:5).

In October 1983, HQ AFLC Commander Gen Mullins and HQ AFSC Commander Gen Marsh jointly announced a memorandum of

agreement with three main points. First, it changed the AFALD to the Air Force Acquisition Logistics Center (AFALC) under the joint direction of Logistics Command and Systems Command. Second, it appointed AFSC as the leader in acquisition logistics policy making to better integrate logistics requirements into the programs. Third, it established a new Deputy Chief of Staff for Acquisition Logistics within AFSC headquarters and the product divisions (37:6).

In January 1985, Secretary of Defense Weinberger decided to realign selected organizations and functions within the Office of the Secretary of Defense. This was done in order to "clarify responsibilities, strengthen controls, and provide emphasis for certain program areas which should receive additional attention." (38:1).

An Assistant Secretary of Defense position was established to report directly to the Secretary of Defense. This executive would devote full time to overseeing the acquisition process, production, contracting, procurement, maintenance, supply, and installations management. In addition, this Assistant Secretary of Defense for Acquisition and Logistics, ASD (A&L), would serve as the Defense Acquisition Executive, a position previously held by the Under Secretary of Defense for Research and Engineering. This would enable the ASD (A&L) to develop the policy and provide the guidance on DOD

acquisition and to manage the procedures outlined in the DOD Directives 5000.1 and 5000.2 (38:2).

The decision has received mixed reviews. Some feel it is good that a single executive is responsible for managing the system acquisition process along with the support system. Others feel logistics is interrelated with personnel and are now separated, while development and production responsibilities should be separated because of inherent conflict of interest. Though the position's "clout" has been questioned, most feel the new incumbent, James P. Wade, could make substantial changes in the treatment of R&M issues (7:30-34). Recent organizational changes were also made at the HQ USAF level to establish focus and accountability for R&M. These R&M advocacy changes were made to offer technical expertise, improved program coordination, and greater R&M exposure. In addition, Lt Gen Russ, HQ USAF DCS/RDA, stated:

Program reviews of reliability and maintainability factors will be scrutinized at all levels. Emphasis from the Inspector General and from the R&M staffs will be increased. Independent review teams will examine the weapon system R&M programs in detail (33:125).

Similarly in March of 1985, Air Force Systems Command announced the formation of a new Deputy Chief of Staff for Product Assurance and Acquisition Logistics. The announcement message described its charter as follows:

The DCS/PL is chartered as the principal HQ AFSC advocate to ensure that we establish and successfully achieve reliability, maintainability, quality, producibility and supportability objectives and

requirements in all AFSC programs. The new organization will formulate command policy that ensures these requirements receive first-line consideration in all source selection, design, and production activities. The principle mission objective is to assure that delivered defense systems and related support equipment/material are of the highest quality, and are reliable, maintainable and supportable. The scope of this mission includes the entire spectrum of product assurance and acquisition logistics activities from technology development to fielding of supported systems. With heavy emphasis on independent measurement and assessment of our accomplishments in these areas (17:1-2).

Due to this increased emphasis on supportability in the last four years and its concomitant organizational and procedural changes, the literature review in the next chapter will primarily cover those articles published since 1981.

Research Objectives

The primary objective of this research is to identify how the DPMLs perceive the factors that prevent more effective reliability and maintainability initiatives during the early phases of the acquisition cycle. In addition, it will present what the DPMLs believe are the best possible solutions to these constraints. Because of some similarities of this objective to the 1982 research of Major Hull and Captain Lockhart, this research will build upon their findings and recommendations. Their study measured the rank-ordered significance of eight pre-selected barriers to ILS as rated by the mid level and junior managers in Aeronautical Systems Division (ASD) and Air Force Acquisition Logistics Division (AFALD). This

study will expand the investigation from one to two product divisions, focus on the DPMLs selected to manage the major programs, and narrow the purpose to impacting reliability in the early phases of the acquisition cycle.

Research Questions

1. How do the DPMLs rank-order seven major constraints as to their impact on impairing the DPML's ability to influence a system's design for improved supportability?
2. Do the DPMLs significantly differ in their perception of the rank ordering of the seven constraints by product division?
3. What other constraints do the DPMLs perceive as significant?
4. What solutions do the DPMLs propose to reduce the impacts of the constraints in questions one and three?

II. Literature Review

Introduction

To better understand the environment in which the DPMLs work, their job, and the research objectives, this chapter will be divided into five primary sections. The first, "Definitions and Relationships," will describe many of the terms used in the acquisition process e.g.: SPO, DPML, product divisions and reliability and maintainability. The second section, "Initiatives in the Logistics Acquisition Environment," will describe the impact of the Carlucci Initiatives, baselining, organizing for logistics research and development, and the Grace Commission Initiatives. The third section, "Reliability and Maintainability", will provide an in depth view of the impact of R&M initiatives, requirements definition, R&M tasks, test and evaluation, RFP evaluation criteria, incentives to enhance R&M initiatives and the importance of trained personnel. The fourth section, "Measured Barriers to Implementing ILS," will describe the 1982 Hull and Lockhart study. The fifth section, "Review Conclusions," will establish the base from which the methodology chapter will be built.

Definitions and Relationships

A system program office is a matrixed organization, headed by a program manager, which is designed to find a

solution to an identified current or projected deficiency in performing an Air Force mission. The selected solution is frequently the development and acquisition of a new system. The SPO will explore various concepts, develop and validate possible alternative solutions, and then manage the resultant new weapon system through initial production. It is the focal point for all agencies in system acquisition as well as the only organization authorized to negotiate with the contractor. Therefore, it is at this working level that the logistics initiatives must be integrated into the system's design and the constraints to designing into the system the optimum level of reliability and maintainability will occur.

The SPO is organized along program management lines. Program management is a special approach to management. It overlaps the functional management structure and enhances communications, coordination, and control. Program management focuses on the achievement of the end product. The program manager is the executive responsible for all phases and functions described by systems acquisition. Within the program office, functional offices are integrated to perform the varied functions essential to acquisition. Among these functional offices is the Integrated Logistics Support Office (ILSO) (18:11).

The DPML is usually either a field grade officer or equivalent civil servant who is usually assigned by the Air Force Acquisition Logistics Center to manage the ILSO office in a SPO. His/her purpose is to interject into the acquisition process the impetus to design the system for supportability. The DPML's purpose in trying to insure

supportability is to lower the long range or life cycle cost of the system. Program managers in the past have been evaluated more on the short run goals of meeting performance standards, remaining on schedule and achieving minimum cost. Therefore, the DPML frequently has had an adversarial role of convincing his/her program manager to divert limited resources from those other goals to the achievement of reliability and maintainability design enhancements which satisfy long run goals. Like the experts in other functional specialities, the DPML is collocated within the SPO and is responsible to the program manager. However, as a non-AFSC asset, the DPML's reporting chain is often different (18:11). His/her evaluation is usually closed out at the Air Force Acquisition Logistics Center or at Headquarters Air Force Logistics Command.

Similar to the DPML, the Director of Logistics (DOL) is usually a Colonel or equivalent civilian grade. His purpose is the same, however, his scope is broader in that several DPMLs usually work for him. He serves as a staff member to the overall program director and insures that all the DPMLs within that SPO are supported and performing their mission.

The DPMLs and DOLs in this survey all worked in SPOs that were involved in major programs. A major program is a designation given by the Secretary of Defense to those acquisition efforts that either involve: over \$200 million in R&D and \$1 billion in procurement funds, special interest

of the Secretary of Defense, joint acquisitions by two DOD components or another nation, or Congressional interest. Because of this designation, the key positions in major programs are usually manned with the more experienced personnel.

Another organizational term is "product division." Air Force Systems Command has divided up its mission of developing and acquiring new weapon systems into five divisions based on the type of systems being developed. Space Division develops satellite systems at Los Angeles AFS, Electronic Systems Division develops communications systems at Hanscom AFB, Aeronautical Systems Division develops aircraft systems at Wright-Patterson AFB, Armament Division develops rockets and guns at Eglin AFB, and Ballistic Missile Office (considered a "division") develops missiles at Norton AFB. In this study, DPMLs and DOLs were interviewed in SPOs of two of these divisions - Electronic Systems Division in Massachusetts and Aeronautical Systems Division in Ohio.

The official definition for reliability, according to Air Force Regulation 80-18, is "the probability that an item will perform its intended function for a specified interval under stated conditions" (16:10). Maintainability is "a characteristic of design which is expressed as the probability that an item will conform to specified conditions within a given period of time when maintenance

is performed by personnel having specified skill levels using prescribed procedures and resources" (30:23).

Reliability and maintainability are separate but related concepts that determine a weapon system's supportability, survivability, mobility, and availability (16:10). Though perfect reliability would be too expensive and practically unachievable, it would eliminate the need for support since an item would never fail. Therefore, the lack of capability to design in product reliability forces us to design in maintainability (30:23).

Reliability is measured in mean time between failures (MTBF) which is calculated by the summation of the operating times between failures over a period of time divided by the number of failures during that time frame. Maintainability is measured by mean time to repair (MTTR) which is calculated by the summation of repair times during a period of time divided by the total number of malfunctions during that period (30:23).

The life cycle cost of a system is determined by fixed costs plus variable cost ($LCC = FC + VC$). Reliability is a fixed cost and has a direct effect on the variable cost of maintenance. The higher the degree of reliability built into the design, the less it will cost to maintain the system. However, since additional reliability costs money there is a point of diminishing return in which the marginal gain of additional reliability will exceed its marginal cost (30:23).

As reliability increases, the life cycle cost of the system will continue to decline until the marginal cost of reliability improvement exceeds the marginal drop in maintenance costs. An operations research analyst for the Army Logistics' Research Office states that this optimum range, identified in figure 1, is not clearly recognizable and must be negotiated by the decision makers. He proposes the use of cost effectiveness analysis (C/EA) to determine how much reliability and maintainability to purchase (30:23-24).

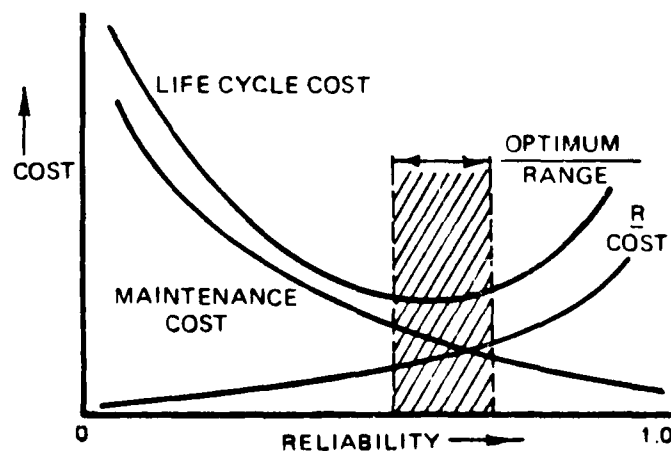


Fig. 1 Relationship of Reliability to Life Cycle Cost

Initiatives in the Logistics Acquisition Environment

In March 1981, after being in office only six weeks, Deputy Secretary of Defense Frank Carlucci began establishing his acquisition improvement program. He started his program with a 30 day comprehensive review. A small working group of knowledgeable acquisition experts gathered recommendations from the various affected agencies. After a month of refining the issues and recommendations, Carlucci issued his memorandum encouraging eight management principles and 31 acquisition initiatives that later grew to 32 (23:5).

Though these initiatives had a "major impact on the acquisition philosophy and procedures and they received much publicity, the program did not propose any new ideas. This participative management approach merely took the best ideas of prior analyses and put them all together in a comprehensive program that emphasized implementation (23:56). Observers of the acquisition process agreed the major differences of Carlucci's initiatives to prior ones were (1) his program was broader in scope, (2) he emphasized implementation, and (3) he kept his watchful eye on its progress long after its introduction (23:6).

In January 1983 Paul Thayer replaced Deputy Secretary of Defense Carlucci, who returned to the private sector. On 5 May 1983 Thayer announced his consolidation of 32 of Carlucci's initiatives into six acquisition improvement program initiatives (6:17).

The sixth initiative, encouraging improved support and readiness, consolidated the Carlucci initiatives of increased system support and readiness, funding for test hardware, contractor incentives for support, logistics and support resources, and improved reliability and support. The main objective was to insure that readiness receives the same emphasis as cost, schedule, or performance. In addition, a major emphasis was to get readiness objectives established and approved by the requirements validation milestone. The new initiative encouraged the separate measurement of logistics funds for R&M initiatives to especially include supportability contractor incentives. DODD 5000.1 and 5000.2 have been revised to reflect the new emphasis on reliability and it is now reviewed at each milestone in the DSARC process (6:9-10).

A literature review of the articles evaluating the effectiveness of the Carlucci initiatives shows a trend from 1981 to 1984 of two themes. First, "pep rally" speeches encouraging the military, Congress, and the industry leaders to get with the program and make it work. Second, "gloom and doom" articles stating this program is just more promises packaged differently. Like the wise men describing the elephant, all were correct from their perspective.

By April 1982, one year after initiation, the negative articles began appearing. Government Executive magazine

conducted a survey of 24 corporate executives. The consensus was that the initiatives were excellent, but they were "still mostly top level talk and grass-roots inaction" (40:30-32).

An editorial proposed that the problems had become so large that they were now literally impossible to solve without direct Presidential involvement (27:46-47). Coincidentally, in early 1983, Air Force Systems Command held a conference to review "how they were doing". The conclusion was that they were working hard, but on the wrong problems (2:20-24). A review of the initiatives at the end of 1983, concluded that there had been improvement, but it was hardly big enough to notice (1:11-12).

Baselining. In addition to the original 32 or 6 consolidated initiatives, several other acquisition initiatives have taken place during the last three years that have affected logistics acquisition. According to a 1984 progress report by General Skantze, then Vice Chief of Staff of the Air Force, the problems are slipping schedules, changing requirements, and escalating costs caused by getting "off track early in the process." Therefore, in 1982, the Air Force started a new concept called program baselining and cost capping. The program directs "all the major players, the operational command, development command, support command, and training command, to accept and agree on, up-front, the requirements, the

program content, and the cost of the specific program" (34:3-4). Though difficult to negotiate, once all the applicable MAJCOM commanders sign the document, no changes are made unless everybody agrees the changes are absolutely necessary. Starting with the B-1B program, the Air Force learned it could adhere to a baseline price. In the '85 President's budget, baselined planned programs include the B-1B, C-5B, Ground Launched Cruise Missile, MX missile, and a few others (34:3-4).

General Marsh, the commander of AFSC, also emphasized the importance of baselining. This means the builder, tester, trainer, and maintainer agree on such weapon system aspects as schedule, performance requirements, and support details. "Then any change made to the baseline will require high level approvals. This will help eliminate many of the changes that have historically caused program cost growth, delays, and caused support funds to be bled off for mission requirements." To back up this "formula for success, will be sufficient numbers of strategically placed acquisition logistics experts" (37:62).

Organizing for Logistics R&D. General Marsh stated that another problem was that no one organization was in charge of support acquisition, availability, and sustainability for combat. AFSC's change in attitude towards logistics has resulted in three new initiatives.

First, since logistics research and development is

showing big payoffs, it needs to be expanded and brought in earlier to enhance reliability to even higher MTBF rates and to reduce life cycle costs. Current examples are engines with 40% fewer parts and very high speed integrated circuitry (VHSIC) technology (37:61). The Molecular Sieve Oxygen Generating System on the B-1B will replace old liquid oxygen systems and their extensive ground equipment thus saving more than \$17 million (33:124).

Second, more emphasis is being placed on the design process to ensure ease of maintenance (like form/fit/function components), integrating new test and diagnostic capabilities, and insistence that equipment design include testability. The B-1B Central Integrated Test Subsystem's elimination of flight line test and support equipment resulted in savings of \$500 million and a 60% reduction in specialized maintenance personnel (33:124). The third initiative is ensuring all ILS elements are "funded, designed, developed, acquired, and deployed before the system is delivered to the user" (37:61-62).

To seek further enhancements, the Air Force has established the Coordinating Office for Logistics Research which "carries out long-range planning for Air Force logistics research and development, determines requirements in this area, and fosters research that will meet the needs identified" (31:31). In addition, AFSC, AFLC and their subordinate AFALC also play a role in R&D. AFSC "provides

half of the Coordinating Office's manpower through 'dual hatted' engineers." Then requirements are packaged and coordinated with these agencies and inserted into "the laboratories' planning and programming cycles" (31:32).

The Logistics and Human Factors Division of the Human Resources Laboratory is also a key player. The Air Force Human Resources Laboratory "conducts research and development relating to human factors, management science, and operations research and thus complements work in the hardware and physical sciences laboratories." Technology transition is also important as it "closes the research loop by identifying specific users and assigning responsibility for application of research results" (31:33).

The Joint Logistics Commanders established in 1984 a Joint Technical Coordinating Group to evaluate each service's laboratory efforts concerning logistics - R&D to more efficiently use the R&D funding. In addition the DOD directed the Air Force to program approximately \$40 million per year in 1984 and 1985 for logistics R&D (7:32).

Grace Commission Initiatives. In 1984, Paul Thayer responded to the Grace Commission review of Defense Acquisition by admitting reform of the process will be difficult and expensive. The Commission made 275 recommendations, of which DOD agreed with about 70%, implementing many immediately. However, recommendations

which contained 80% of the estimated savings required congressional actions. In addition, the program stability sought in the initiatives was also hurt by Congress cutting, reducing, and stretching out programs. Congress also restricted the power of DOD's principal tool to stabilize programs by reducing multi-year procurements and economical order quantities. By approving only 7 of 14 FY 84 multi-year candidates, \$1 billion in potential savings was lost (36:2-4).

Reliability and Maintainability

In a special study on R&M improvements prepared for the Vice Chief of Staff of the Air Force, an air staff logistics plans and programs analyst stated, "Reliability and maintainability have significant impact on supportability, survivability, mobility, and system performance and availability" (16:10). Support costs are brought down when the reduced failures lessen the requirement for spares, equipment, and personnel which further reduces training and facility costs. Survivability is increased two ways: first, through less dependence on vulnerable ground facilities and, second, through enhanced mission protection equipment such as electronic counter-measures and navigation. Mobility is enhanced by R&M reducing the numbers and types of equipment, personnel, and spares necessary to deploy in support of an operation. A Rand study showed how a reduction in F-15 line replaceable

units would have deleted the mobility requirement of 22 pallets of cargo and 40-50 maintenance personnel per squadron. System performance and availability would be enhanced through reduced repairs making more aircraft available for missions and peacetime training sorties (16:10-11).

Another way of illustrating the impact of reliability is that if in-commission rates of aircraft can be doubled, the number of aircraft capable of being committed to battle is also doubled, which is much cheaper than buying twice as many aircraft (19:13).

Requirements Definition. Decisions made in the early concept exploration and demonstration validation phases drive the cost and characteristics of a system for its entire life. By the end of the concept phase, Milestone I, 70% of a system's life cycle costs have been determined. By Milestone II, 85% of life cycle costs are committed even though the funds affected will not be spent until years later. These early decisions determine later support concepts and system R&M characteristics. Thus supportability problems are often locked in before even being identified. This problem is compounded when R&M testing and design improvements are deferred due to cost or schedule constraints (16:11).

The most important consideration during the concept phase is developing meaningful requirements in the

statement of need (SON) and the contract statement of work (SOW) (16:13). A system's R&M requirements are established primarily by the user commands (11:25). A new Air Force objective is that HQ USAF will set resource goals that relate directly to mobility, manpower, and life cycle cost requirements. These will then be monitored against firm program requirements at the major commands (33:125). Past SONs have been vague in defining R&M requirements by using comparisons to existing systems or generalities instead of using meaningful, quantitative methods to derive, state, and measure analyzed needs. Likewise, the statements of work tend to be copied phrases from the SONs (16:13). Unfortunately, staff personnel who derive requirements may not be aware of all the R&M implications. How a failure is defined is very important. The difference in interpreting MTBF as only "hardware failure" or "regardless of cause failure" can have a significant impact on the overall effectiveness of a system once it is fielded (11:25-26).

Some believe the major problems in the early phases are contracting restrictions and military/contractor mindset constraints. In an effort to change these issues, Deputy Secretary of Defense William H. Taft issued two memoranda in January and December of 1984 establishing the "Streamlining Initiative." This initiative calls for more contractor initiative and a creative partnership with industry. The principle goals are to preclude untailored

application of specifications and the increased use of specifying results required rather than detailed "how-to procedures" (14:6-7).

Reliability and Maintainability Tasks. Since all programs experience funding limitations and tight schedules, only the priority items will be fully funded. There is no single best R&M priority list since each program is different. However, at a 1981 Air Force Systems Command R&M Workshop, a panel composed of 25 R&M experts from major programs, depot operations, policy, and research and development organizations ranked the R&M tasks in Table I as what they perceived as the most cost effective (11:25):

TABLE I
Most Effective R&M Tasks as Perceived by AFSC R&M Workshop

Reliability	Maintainability
1. Parts Derating	1. Accessibility
2. Parts Selection and Control	2. Testability
3. Failure Analysis & Corrective Action	3. Logistics Supportability
4. Parts Screening	
5. Burn-In	

A similar study done by Rome Air Development Center, determined that certain factors were common in programs whose field reliability exceeded their stated requirement

and that certain factors were common in those which failed to achieve their stated requirement. The reliability successes all had meaningful reliability requirements, Air Force and contractor emphasis on reliability, and excellent parts control and test programs. The failures had complex systems, rigorous environmental requirements, routine reliability emphasis, mandated off the shelf hardware, and software problems (11:25).

After the requirements are established, one of the first tasks is deciding on the acquisition strategy of design, commercial-off-the-shelf, or a combination of both. Off the shelf procurement saves in initial cost and time. However, this commercial equipment may not withstand the military environment, may create configuration management problems if the manufacturer changes design, may be lacking in available spare parts and maintenance manuals. In addition it has been shown that extensive usage of commercial parts locks the Air Force into one supplier, which results in higher prices and can also threaten readiness if the contractor discontinues the product line. To evaluate all these situations, a strong parts control board or parts advisory group should review the contractor's preliminary parts list. In Air Force weapon systems, about 90% of the electronics can be handled with current technology or previously approved parts. These boards will emphasize proven parts, materials, and

processes where possible. Knowledgeable parts engineers can be requested for these boards from the Defense Electronic Supply Center and other various sources within the DOD (11:26-28).

In addition to parts selection, another R&M priority is parts derating. Derating is reducing the electrical, mechanical, and environmental operating stresses well below the maximum level a part can sustain in order to increase the lifetime of the part. Though there is no recognized derating standard, there is a document now available from Rome Air Development Center that allows an Air Force reliability engineer to compare a contractor's proposed derating criteria with those recommended (11:28).

Test and Evaluation. During the design phase, early emphasis on maintainability will encourage using standard and proven designs, fail-safe features, sufficient well-placed test points, and worst-case design techniques. Testability is the capability to accurately detect and locate failures. An early involved maintainability/testability program will insure: (1) that testability requirements are based on operational requirements, (2) an optimum mix of built-in-test (BIT) and external test equipment (ETE) is selected, and (3) the testability responsibilities for the government and contractor are clearly identified (11:28-29).

Testing does not mean the DOD engineers have to evaluate the contractor's design. The government's

responsibility is to evaluate the reliability of the product through both developmental and operational testing. Analysis of the data, by an independent development evaluator, operational evaluators, and the user is essential in determining an accurate reliability of the system. However, the different evaluators will often give different analyses which the decision maker must evaluate. The different analyses will occur mostly due to honest differences in opinion of what constitutes a failure and because of different but equally acceptable analytical techniques (21:26-27).

In 1983 the chief executive officer for Northrop Corporation felt R&M could best be achieved through three steps. First, place greater emphasis on R&M during the concept and development phase during questions of tradeoffs. Second, invest more up front in test hardware and apply a strict testing procedure called "test, analyze, and fix." This procedure focuses on correcting early failures under realistic conditions. Third, to project requirements or predict results, use plans based on new technologies as opposed to those based on previous weapon systems (19:14-16).

RFP Evaluation Criteria. Reliability begins during the design phase. Some argue that engineers need to be better trained in the reliability studies of mechanics, strength of materials, thermodynamics, digital circuitry, and micro-processing. However, most engineers believe they know how to

"design in" reliability but are not in a position to set their own priorities. In fact, management determines the degree of reliability instead of designers (21:25-26).

Three regulations, DOD 5000.1, DOD 5000.2, and DOD 5000.39, all strongly emphasize that management must give equal consideration to life cycle cost, supportability, and systems readiness from the beginning of the acquisition cycle. However, past Requests for Proposal (RFPs) and their subsequent contract awards have shown much more weight applied to cost and performance. In a survey of top managers of defense related industries, contractors were asked what percentage weighting they thought was applied to supportability areas in awarding contracts. Two thirds of them estimated it as insignificant or less than 10%. However, the emphasis appears to be changing in recently distributed RFPs. More than 90% noted the increased emphasis citing added requirements for life-cycle/support cost analysis. Yet, the respondents unanimously believed that if a funding limitation required a cutback, the supportability area would still be the first to be cut back (39:5-6).

One new program to raise the Air Force consciousness of reliability and maintainability is R&M 2000. It was instituted in February 1985 when the Assistant for Reliability and Maintainability was created under Lt Gen Marquez, HQ USAF DCS/LE. The program's personnel will

advise the Air Force Systems Acquisition Review Council (AFSARC) if the weapon systems the Council is considering do not meet some "as yet undecided minimum standards for reliability and maintainability." Though some are skeptical of the program, Lt Gen Marquez believes it will be effective "because of the AFSARC connection's ability to stop program approval" if the R&M issues are not weighed heavily enough in the RFP or its evaluation (32:42-44).

To aid in weighing R&M more, RFPs will have to clearly identify to contractors how supportability factors will be weighed. Similarly, DOD should award contracts for innovative approaches for supportability (39:7). One possible way to avoid restricting potential R&M improvements yet still control the program is to state the minimum requirement and then make it clear a contractor can improve his selection score by proposing a design that exceeds those requirements. This encourages contractors to perform cost tradeoff studies during the proposal stage (35:135-136).

When an individual buys a car he can determine cost, riding comfort, power, and appearance. On the other hand, since he cannot determine reliability until after he has purchased the vehicle, he tends to give it less weight in his purchase decision. Similarly, the Air Force has tended to emphasize physical and mission performance characteristics in our choice of systems. Aware of this phenomenon, contractors will not give reliability a high

priority unless they know that independent reliability testing is to be conducted and production contracts or incentive awards depend on the test outcome (21:26).

Low emphasis on reliability is not peculiar to the military. Two similar articles discussed how U.S. corporations place less emphasis on product reliability than Japanese firms. Schools and U.S. firms are beginning to teach that quality is no longer a tradeoff of performance and that quality can be a key competitive strategy (8:8). As a result of what we have learned from Japanese industries, more emphasis is being placed on reliability engineering in early product design (12:71-72).

Incentives to Enhance R&M Initiatives. A significant method in incentivizing reliability is through the use of award-fee contracts which provide bonus payments over and above the contract price when specific goals are exceeded. These goals can be mean times between failures, mean times to repair, factors of operational availability, or other quantifiable measures (35:139). Two recent examples cited were the Air Force's F-16 and the Navy's F/A-18 programs. The largest and most innovative one was the Navy's program that earmarked \$39 million for contractor incentives to reduce operating and support costs. There was a \$15 million life cycle cost incentive, a \$12 million reliability incentive determined by mean flight hours between failures at 1,200 and 2,500 flight hrs., and a \$12

million maintainability incentive determined by maintenance man hour requirements at 1,200, 2,500, and 9,000 flight hours. To insure designs capable of attaining the awards, the McDonnell Corporation collocated their logistics and design engineers. Likewise, the Northrop Corporation established incentive programs with 34 of its equipment suppliers. The bottom line of all R&M emphasis, funding, and incentives must be the reliability of the system. In 1983, the F/A-18 had a maintenance man-hours per flight hour of only 26.2 which was much better than the 56.0 hours for the F-4 and 45.4 hours for the A-7E (20:3-7).

Trained Personnel. A General Accounting Office (GAO) report stated that other acquisition constraints include the military's assignment rotation policies and a career path "lacking structure" which is evidenced by the insufficient training offered and the few incentives for career commitment. The unmanaged "career field's need for professionalizing" has received recent attention from Senators Roth and Cohen who believe many of the acquisition problems are people problems rather than system problems. Senator Quayle recommends "two separate but equal career paths" for operations and acquisition in order to train and maintain a corps of skilled personnel. Though others believed the operational background can provide substantial insight, most senior military leaders and Congressmen agreed with the GAO report that more training and assignment controls are necessary (9:16-25).

Measured Barriers to Implementing ILS

In 1982, Major Hull and Captain Lockart researched the barriers to fully implementing integrated logistics support (ILS) in system acquisition as perceived by ILS managers and program managers in the Aeronautical Systems Division. The Hull and Lockhart study considered all phases of the acquisition cycle as opposed to just the early phases, and it considered barriers to the entire scope of ILS as opposed to just making design changes for R&M improvements. Likewise, the Hull and Lockhart study concentrated on measuring the perception differences of senior and junior level managers and the perception differences of the ASD program management personnel versus the AFALD logistics personnel. Though different in these respects, many of the constraint factors are common and thus their study provides a base from which to expand.

Their research concluded that there was no significant difference in how the junior and senior level managers perceived the relative ranking of the eight factors (18:68-69). Based on this finding, this research was limited to only senior level managers. Their research also concluded that there was no significant difference in the perceptions of the relative ranking of the eight factors between the organizations of ASD program/project managers and AFALD logistics managers except for the one factor of DPML authority (18:67). Based on this finding, this

research was limited to only the logistics managers.

The following "is the rank order of the significance of the eight assumed barriers to ILS as rated by the ASD managers and as rated by the AFALD managers and how they compared" (18:69).

TABLE II

Proposed Barriers Ranked by Organization Mean Ratings

Rank	ASD		AFALD	
	Factor	Mean	Factor	Mean
1	Design Goals	71.73	Design Goals	68.32
2	Goal Conflict	66.05	Goal Conflict	66.11
3	Skills	58.28	DPML Authority	63.78
4	Work Relations	50.65	Skills	58.00
5	DPML Authority	50.40	Logistics T&E	53.57
6	Tools	48.00	Org. Structure	47.62
7	Logistics T&E	47.85	Tools	47.14
8	Org. structure	43.88	Work Relations	42.97

The factors rated above were defined on the survey instrument in the following manner:

1. ORGANIZATIONAL STRUCTURE: Primarily the low relative position of the integrated logistics support office within the program office, and the dual chain of command for the logistics manager.
2. DPML AUTHORITY: The lack of decision-making authority delegated to the logistics manager, such as inadequate inputs, coordination, or approval over the way in which program funds are spent and other program decisions are made.

3. LOGISTICS MANAGEMENT TOOLS: The misuse or non-use of such quantitative and qualitative tools as Life Cycle Cost (LCC) models, Logistics Supportability Analyses (LSA), and Lessons Learned repositories during support and product design.
4. LOGISTICS SKILLS: Failure to employ appropriately skilled logisticians during the different phases of the acquisition cycle. Due possibly to a lack of skilled or available specialists.
5. WORKING RELATIONS: Lack of communication or cooperation between the logistics personnel and other functional specialists within the program office.
6. LOGISTICS DESIGN GOAL DEFINITION: Inadequate definition of logistics design parameters and requirements in program directives, combined with the difficulty in translating those parameters which are identified into achievable, verifiable goals for the contractor.
7. TEST EVALUATION: Inadequate T&E for supportability characteristics due to poor planning, limited budgeting, or other resource and time constraints.
8. GOAL CONFLICT: For example, system design trade-offs which consistently and forcefully emphasize performance oriented goals over long-term supportability goals.

The Hull and Lockhart study also presented comments provided by the subjects to explain their ratings. These comments showed great disparity in their evaluation of the factors. The differences were often based on the phrasing of the factors, the wide spectrum of acquisition phases involved, and the particular situations in each system program office. The major areas they felt were not represented in the eight factors were funding control by DPMLs, rapid turnover of personnel, lack of training, and failure to become involved earlier in the programs (18:103-134).

Review Conclusions

This literature review began with the broad changes in the acquisition environment and continued to narrow the focus down to the predominant factors that influence design changes for supportability. Starting with the Carlucci and Thayer programs, the logistics initiative resulted in the acquisition regulations and DSARC review procedures to reflect the new emphasis on earlier involvement with R&M issues. Other programs, such as baselining, helped prevent changes that bled off supportability funding for performance tradeoffs. Concluding the broader issues was the study of how R&M issues affect the warfighting capability.

Then several specific factors were reviewed that contribute to increased supportability with a system's design. As a corollary, their failure to be fully acted upon would be a constraint to implementing design changes for supportability. General Marsh stated logistics research and development needed to be expanded and brought earlier into the acquisition process. An air staff officer expounded on how vague R&M requirements have been defined in statements of need and statements of work. Furthermore, several articles emphasized the need for trained personnel in the areas of reliability design engineering and acquisition management. The need for early testing under realistic conditions against viable operational

requirements was also heavily emphasized. Another area covered was giving supportability issues equal weight to performance in the evaluation of requests for proposal and subsequent contract awards. Similarly, the need for incentivizing reliability and maintainability through award fee contracts was stressed. Two other areas, the dual chain of command organizational structure facing the DPML and his perceived lack of authority, were measured in 1982 Hull and Lockhart study. Both areas were rated as significant but received adverse responses.

While these R&M issues reflect the most frequent topics in logistics professional journals, they are not assumed to be all-inclusive. Factors outside the managerial realm of the Air Force, such as Congressional influence on program stability, were excluded.

III. Research Methodology

Research Strategy

To answer the four research questions, a research strategy was developed to collect a representative sample of the perceptions of the DPMLs and DOLs in Aeronautical Systems Division and Electronic Systems Division that manage major programs. Based on a literature review of what recent authors and senior officers felt were problems in achieving R&M initiatives and on the 1982 Hull and Lockhart study, a list of the seven most probable constraints to initiating design changes for supportability was developed. The list was then evaluated by the DPMLs to measure the factors' relative impact. Statistical analyses tested for any significant differences between several different groupings in how the logisticians rated the relative importance of the seven factors. In addition, the DPMLs and DOLs provided other factors they perceived as significant. To enhance the applied value of the research, their perceptions of how to best resolve these issues were collected and presented.

The Instrument

Collecting data of this type requires either a personal interview, telephone interview, or mailed survey approach. In evaluating these three approaches several factors were

considered. The mailed survey approach was rejected due to the limited size of the population and the importance of attaining a high response rate. Mail surveys have been shown to have a strong bias of nonresponse especially when the respondents owe no allegiance to the sponsoring organization. In addition, mail surveys would not have been suitable for attaining large amounts of information or probing deeply into questions as this research required. Likewise, respondents tend to refuse to cooperate when the mail questionnaire is long and complex as this research would have required (10:308). The telephone interview approach was rejected since that instrument prohibits the use of complex scales and questioning which is inherent in evaluating the relative significance of 7 complex abstractions (10:307).

The personal interview approach was selected as most appropriate for this research effort since it eliminates the most serious shortcomings of the alternatives. In addition, the personal interview provided three additional advantages:

- 1) It would encourage greater depth and detail of information since the subject was more likely to concentrate and devote time to the question.
- 2) The volume and quality of their proposed solutions would increase since it is easier for respondents to vocalize opinions than to write them.

Similarly, the personal interview would allow expansion on proposed solutions and through the interaction, the researcher could gain a more complete understanding of the subjects comments and physical cues (18:33-34).

- 3) There would be an improved quality of responses by enabling the interviewer to monitor the conditions of the interview, prescreen respondents, and to adjust the language of questions by providing on-the-spot explanation in order to limit missing and invalid data (10:294).

A structured interview approach was selected and designed to be self-explanatory so that it could stand alone or with little explanation. The structured approach was selected for the following reasons:

- 1) Increased uniformity between interviews through standardized wording.
- 2) Minimized diversity of interpretation of the questions.
- 3) Increased reliability in comparing results by maintaining a similar instrument to the Hull and Lockhart study.

Attachment A is a copy of the interview form used and is crucial in understanding the remainder of this study. The five page form consisted of five parts: the survey information sheet with a hypothetical scenario and set of

instructions, a personal data sheet to collect demographic information on the respondents, a listing of the seven factors being rated with a short definition of each, a graphic rating scale to rate the seven factors, and a sheet containing two open ended questions for gathering additional constraints and recommended solutions to all the constraints.

The hypothetical scenario and instructions helped foster uniformity. The hypothetical case was intended to encourage the respondents to use both their past experiences and personal judgement. The instructions were designed to help facilitate the inherent complexity of marking the ratings of the seven factors on a graphic scale. The instructions encouraged the reading of all the factors before attempting to rate them. This was done in order to prevent the position of the factors on the list, from affecting the rating of the factors (18:34-35). The five demographic questions on the personal data sheet enabled statistical analyses of the respondents' ratings by various experience level measurements and by product divisions. The seven factors rated were selected from the results of the literature review. The factors were randomly arranged in order not to influence their ratings. The format and size of their definitions were also kept compatible. The definitions included examples of certain issues that would be considered part of that factor. Every attempt was made to avoid any biasing through terminology.

The graphic scale was selected due to its ability to generate both the rank-ordered data to respond to research question one and the interval data for the statistical tests to respond to question two (18:35). Additionally, the scale was used in the Hull and Lockhart study and its continuance would enhance the reliability of comparing the results of the two studies. The basic assumption was that the DPMLs could and would make good judgements (10:263). Since all the factors were rank ordered on the same scale, the respondents were visually cued to interpret their perceptions in terms of the same standard. With each factor placed relative to the others, a rank order was implied (18:35-36).

Several guidelines were followed in developing the graphic scale (18:36).

- 1) The rating line was long enough to allow discrimination among the seven factors, but not long enough to disrupt the rater's unity of continuum.
- 2) The line was continuous depicting the continuity of the effects on R&M being measured.
- 3) The "high" impact end was placed at the top.
- 4) To discourage error of central tendency, the phrasing of the descriptive cues on the ends were not too extreme.

- 5) The end cues were set in enough to allow room for more extreme ratings.
- 6) The rankings were measured in millimeters thus enabling numerical values to be assigned.

The fourth part consisted of two open ended questions. The first requested any additional constraints that were not included in the seven factors in order to insure any important constraints were not overlooked. The second elicited what the DPMLs believed to be the best course of action to reduce the impact of the various constraints.

Instrument Pretest

The instrument was pretested on the Air Force Institute of Technology personnel. Due to the similarity to the Hull and Lockhart instrument, the only objectives were to gain experience in administering the interview, to determine if the interview time was reasonable, to evaluate the clarity of the test, and to evaluate content validity (18:37). As a result, a few changes were made in the wording for clarification and some administrative techniques were modified.

Sample Selection

The target population was determined to be the current DPMLs and DOLs assigned to major acquisition programs within Aeronautical Systems Division and Electronic Systems Division. Experience was important for two reasons in this

study. First, the ratings of the seven listed factors by inexperienced personnel could skew the statistical results. Second, qualitative answers to research question four, solutions to reducing the impact of the constraints, required a thorough knowledge of what happens in the early acquisition phases and how any changes might affect other related activities.

However, due to the very small number of DPMLs and DOLs that had even one year experience as a DPML in the early acquisition phases, the target population was looked at as three concentric circles. First, 28 of the 32 major program DPMLs and DOLs at ASD and ESD were interviewed and statistical results were calculated. Then statistical analysis were recalculated on a second group containing only the 15 individuals that had three or more total years within acquisition and 1 year as a DPML during any phase. Finally, the statistical analysis was again recalculated for a third group containing the 10 people who had 3 or more years total acquisition experience, but also 1 year as a DPML in the concept exploration, demonstration validation, or early portions of full scale development phase. The assumption was made that an incumbent of a DPML position in a major program for these periods of time was relatively knowledgeable. No attempt was made to differentiate based on personal factors.

Having defined the target populations, the first step was determining the major programs within each of the two product divisions and their incumbents. Senior staff members in the Air Force Acquisition Logistics Center provided me an alpha roster of these positions, their incumbents, the current work locations and phone numbers. Seventeen positions were identified within ASD and 16 of them were interviewed. Fifteen were identified within ESD. Due to the travel restrictions and scheduling problems only 12 of these were interviewed.

Subject Contact Plan

Because of the travel requirement to ESD, it was determined the optimum time for these interviews was during a break in the researcher's classes. Therefore, all ESD DPMLs were contacted and interviewed first, and then the ASD subjects were contacted later over the next month. In both divisions, the subjects were contacted by telephone, the researcher introduced himself, explained the research objectives and time requirements, and established an appointment. A record was maintained of all contacts and interviews. These were correlated to a numbered interview schedule which enabled follow-up contact but also provided anonymity for the subjects.

Conducting the Interview

In order to improve subject receptiveness, each interview was preceded by brief introductions, explanations of the objectives of the study, the beneficial values of the findings, and a reassurance of the confidentiality of the interview. The subject first completed the demographic questions. The subject then received the instruction sheet and the graphic scale for rating the seven factors. Though designed to stand alone, if the subject had any interpretation questions they were answered. However, interaction at this point was purposely limited in order to reduce any bias on the rating results (18:42-43).

After finishing the rating exercise, the subject was then asked to identify any other significant constraints not listed or covered by the seven factors. Finally, the subject was encouraged to propose any recommended solutions for reducing the impact of any of the constraints. This portion was undoubtedly the most difficult to administer in that it required motivating the DPMLs to be innovative and as specific as possible in their recommendations. The researcher recorded their comments (usually paraphrased) on the numbered raw data collection sheets.

Data Analysis

The research objectives identified four goals for analyzing the interview data. The first goal was to determine how the DPMLs rank-order certain constraints that

impair their ability, during the early acquisition phases, to influence a system's design for improved supportability. To do this, individual ratings for each factor were quantified by measuring the distance in millimeters from the bottom of the scale to the respective hash mark rating by the subject. Appendix B is the responses of the three groups that were input into the computer. The SPSS statistics package then calculated the group means from the individual scores. Appendix C is the Statistical Package for the Social Sciences (SPSS) program code used to generate the statistical information. The factors were then listed by magnitude of the mean ratings. Though the list was not considered all inclusive or absolute, it did provide a prioritized listing of the major program DPMLs perceived the relative significance of these factors.

The second objective was to determine if the DPMLs significantly differed in their perceptions by their product divisions. As stated earlier, statistical analyses were repeated after omitting first the less experienced in overall acquisition and then again after omitting those having little experience in the early acquisition phases. T-tests were based on the assumption that the underlying population distributions were normal and the variances were near-equivalent. Previous research has shown that most opinion surveys approximate a normal distribution. However, even when the distribution differs, the statistical tests

are relatively unaffected (18:45-46). The t-test procedure also analyzed the differences in the group means between the two product divisions based on the three target groupings. The mean score differences for each of the seven factors was tested at the .05 significance level. Due to the length of the output data, samples of the pertinent tests are included. Appendix D is a sample of the computer output data comparing the mean ratings of ASD and ESD and the statistical tests performed by the researcher on the computer information. In addition, the three target groups were also tested for significant differences based on grade, time in acquisition, time as a DPML, and time in the early phases. Appendices E and F contain samples of these statistical tests.

The third objective was to identify any other factors the DPMLs felt were significant. The raw data collection sheets were read, evaluated, and then placed into natural groupings. Though considerable subjectivity was involved in this analytical method, every attempt was made to remain objective.

The fourth objective was to organize and present the respondents' perceptions of how best to resolve these identified constraints. Though they agreed as to what they believed were the most and least significant constraints, they often varied in what they felt should be done, if anything, to resolve the constraints. After each factor,

the various proposed solutions were listed in order of the solutions mentioned most often. When only a few mentioned a solution, it is not inferred that others agreed or disagreed for they merely may not have thought of that solution at the time. No attempt is made to judge which would be the best.

IV. Findings and Analysis

Introduction

In ASD and ESD there are 32 designated DPMLs and DOLs of major system programs. Twenty eight of these people were interviewed and their responses make up the data base for this research. When the research was originally planned, it was assumed that the DPMLs of these largest programs had extensive acquisition and DPML experience. In addition, it was assumed that their experience levels were somewhat comparable. Once the wide variance in experience levels were discovered, the 28 respondents were categorized into three concentric groups.

The first group included the entire 28 respondents. The second group included only the 15 people in group one who had three or more years total acquisition experience and at least one year as a DPML during any phase. The third group included only the ten people in the second group that had one year experience as a DPML in the early phases of concept exploration, demonstration validation, or early portions of full scale development. By dividing the respondents into these groups, it was possible to determine if the differences in their experience levels was of any significance. These findings are presented during the analysis of research question two. The demographic composition of the three groups are summarized in Table III.

TABLE III
Demographic Composition of Respondents

Grouped By:	Group 1	Group 2	Group 3
Product Division:			
ASD	16	10	6
ESD	12	5	4
Grade:			
05/GS14 and below	23	10	7
06/GS15	5	5	3
Experience in Early Phases:			
Less than 1 year	16	5	--
One or more years	12	10	10
Overall Acquisition Experience:			
Two or less years	8	--	--
Three or more years	20	15	10
DPML Experience:			
Less than 1 year	11	--	--
One or more years	17	15	10

Research Question One

The first objective was to identify how the DPMLs rank-order the seven constraints as to their impact on impairing the DPML's ability to influence a system's design for improved supportability. To satisfy this objective, the factors were ranked according to each factor's mean score or average measurement on the graphic rating scale. The rankings in Table IV show how the DPMLs and DOLs generally perceived the constraints.

TABLE IV

Proposed Constraints as Ranked by All DPMLs and DOLs

Rank	Factors	Mean
1	Requirements Definition	65.5
2	Trained Personnel	59.8
3	RFP Evaluation Criteria	51.3
4	Logistics R&D	43.4
5	Test and Evaluation	35.3
6	DPML Authority	34.6
7	Organizational Structure	21.6

The means of the ratings in Table IV are spread out leaving a clear distinction between the ranking of the factors with the only exception being between Test and Evaluation and DPML Authority which are both rated low in fifth and sixth place. However, since the total group of respondents had less DPML experience and early acquisition experience than originally expected, it was prudent to also rank the means of the factors as perceived by group two and group three to see if there were any significant differences. The ranking and mean ratings of group two and group three are shown in Table V.

TABLE V

Proposed Constraints as Ranked by the More
Experienced DPMLs and DOLs

Group 2			Group 3	
Rank	Factor	Mean	Factor	Mean
1	Requirements Def.	63.7	Requirements Def.	66.2
2	Trained Personnel	61.9	Trained Personnel	63.9
3	RFP Eval. Criteria	50.8	RFP Eval. Criteria	52.3
4	Logistics R&D	41.8	Logistics R&D	42.6
5	Test and Eval.	37.6	Test and Eval.	41.2
6	DPML Authority	31.9	DPML Authority	26.0
7	Org. Structure	24.3	Org. Structure	21.1

As can be seen by comparing the rankings, all three groups agreed on the ranking of the seven factors. The F-tests and t-tests performed on each of the factors rated support these rankings. This implies that the DPMLs and DOLs of the major programs, regardless of experience level, have a generally uniform perception of the impact of the seven factors on impairing their ability to influence a system's design for improved supportability. None of the differences in the rated means were found to be statistically significant at the $\alpha=.05$ significance level. Though not significant differences, there were a few interesting trends among the various experience levels.

Group two rated the factors Trained Personnel and Test and Evaluation higher than group one, while group three rated those same factors even higher than group two. Conversely, the more experienced respondents placed less emphasis on the factor of DPML Authority. Group two rated it lower than group one and group three rated it even lower.

Research Question Two

The second objective was to identify if the DPMLs in ASD and ESD significantly differed in their perception of the rank ordering of the seven constraints. Using a t-test at a significance level of $\alpha = .05$, the two product divisions were not significantly different on any of the seven factors. In all but the Requirements Definition factor, the variances were found to be equal, so the pooled variance estimator was used. In the Requirements Definition factor a separate variance estimator was used. Table VI shows the comparison of rankings in ASD and ESD.

TABLE VI
Comparative Rankings of all ASD and ESD Respondents

ASD			ESD	
Rank	Factor	Mean	Factor	Mean
1	Requirements Def.	62	Requirements Def.	70
2	Trained Personnel	60	Trained Personnel	59
3	RFP Eval. Criteria	52	RFP Eval. Criteria	51
4	Logistics R&D	47	Logistics R&D	39
5	Test and Eval.	39	Test and Eval.	37
6	DPML Authority	34	DPML Authority	29
7	Org. Structure	23	Org. Structure	19

The factor generating the widest range of opinions, or largest standard deviation, within both ASD and ESD was the perceptions of the impact of DPML Authority. Interestingly enough, this same factor was the only factor in the Hull and Lockhart study on which the ASD and AFALD respondents differed significantly.

ASD/ESD Experienced DPMLs Compared. To insure that the more experienced DPMLs and DOLs (groups two and three) in ASD and ESD did not differ significantly, they were also tested. The rankings of group two and group three differed from each other slightly and both differed from group one. However, none of the differences were statistically

significant at the $\alpha=.05$ level. Though not statistically significant, the biggest difference in comparing the more experienced respondents within ASD and ESD was those in ASD ranked Logistics R&D third with a mean of 53 while ESD's experienced respondents ranked it fifth with a mean of only 27. An explanation for this difference might be that ASD had more Colonel DOL respondents who all rated Logistics R&D higher than did the junior DPMLs.

Junior/Senior Respondents Compared. In addition to comparing ASD and ESD respondents, the perceptions of the junior and senior grade respondents were also compared. In all of the various comparisons done in this study, the largest variance of answers within each group occurred when grouped by grade. In addition to the pooled varianced t-tests, which showed no statistically significant difference at the $\alpha=.05$ level, the large standard deviations within each group showed there was not any real consistency based on rank. The only general tendency was that in all three experience level groups, the senior respondents ranked Logistics R&D higher and RFP Evaluation Criteria lower than the junior respondents.

Inexperienced/Experienced Respondents Compared. A third comparison was made between the respondents with less than three years of acquisition experience with those with three or more years experience in Table VII. When this comparison was done, one factor was found to be

statistically significant at the $\alpha=.05$ level. The inexperienced managers rated the factor of DPML Authority significantly higher than the experienced respondents. This difference in perceptions seems logical since the newer personnel often lack many of the skills and rank that enable the more experienced people to work around the lack of a formal power base.

Another factor was almost statistically significant at the $\alpha=0.5$ level. The Test and Evaluation factor was rated 35% lower by the less experienced group than by those with three or more years in acquisition. Several inexperienced respondents stated this is an area they were unfamiliar with and thus rated it lower for that reason.

TABLE VII

Comparison of Inexperienced and Experienced Respondents
in Acquisition

Two or Less Years			Three or More Years		
Rank	Factor	Mean	Rank	Factor	Mean
1	Requirements Def.	65	1	Requirements Def.	66
2	Trained Personnel	58	2	Trained Personnel	62
3	RFP Eval. Criteria	55	3	RFP Eval. Criteria	49
4	Logistics R&D	49	4	Logistics R&D	41
5	DPML Authority	48	5	Test and Eval.	39
6	Test and Eval.	25	6	DPML Authority	29
7	Org. Structure	21	7	Org. Structure	22

Time as a DPML Compared. A fourth comparison was made between the respondents with less than one year as a DPML and those with one or more years experience. None of the differences in factor ratings were statistically significant at the $\alpha=.05$ level. Even though DPML authority was again rated higher by the inexperienced DPMLs, it was much less pronounced since many of the newer DPMLs had spent several years in logistics acquisition before becoming a DPML.

Early/Late Acquisition Experience Compared. A fifth comparison was made between the respondents with less than one year in the early acquisition phases and those with one or more years experience. None of the differences in factor ratings were statistically significant at the $\alpha=.05$ level. The less experienced respondents again rated DPML Authority higher. In addition, the experienced respondents also rated Trained Personnel almost significantly higher.

Research Question Three

The third objective was to identify any other significant constraints that impact the DPMLs. Fourteen of the 28 respondents offered other significant constraints which were subjectively grouped into seven areas. Though some were closely related to the original seven constraints, all responses were listed. The number of respondents who mentioned each issue is given to only provide a better perspective of the overall responses.

When only a few mentioned a constraint, it is not inferred that others agreed to disagree for they merely may not have thought of it at the time. Likewise, this should not be considered an inclusive list of all additional constraints to the original seven. However, it does provide a good "snapshot" view of what additional constraints were on the minds of the DPMLs on the days they were interviewed.

1. Program Director (PD) priorities. Nine respondents felt if a PD is not convinced that R&M expenditures are of a high priority, none of the DPML's initiatives will be successful. They stated that SPOs only contract and incentivize what the PD wants since it is AFSC not AFLC money being used.

2. Manning Issues. Several respondents brought up manning constraints that fell within six areas:

- 2.1 Manpower Authorizations. Eight respondents remarked there is no overall manning plan or OPR since the logistics personnel come from 6 or more military and civilian AFSCs. Currently the slots are justified through various channels, and the SPOs applying the most pressure get the most people. Almost all of the respondents felt there were not enough people assigned (trained or untrained) to do the job right.

- 2.2 Continuity. Six criticized the "revolving door" of personnel turnovers which allowed the experienced

personnel to leave without regard to their criticality in a program or its timing to significant milestones.

2.3 Relation to R&M Engineers. Six also remarked that having the R&M engineers work in the engineering section instead of for the DPML creates problems in establishing consolidated logistic efforts.

2.4 Basket SPOs. Three stated that the AFALC staff does not understand that the smaller SPOs do not have the resources to train their own people on the job as well as the larger SPOs. The AFALC often assigns the new trainees to the smaller SPOs and then moves them to the bigger SPOs after they become productive.

2.5 ALC Support. Two brought up the point that the ALCs are too reluctant to commit travel funds and personnel during the early phases of a program. They felt this leads to important sources of expertise not being available during the times they could have the biggest effect.

2.6 Meaningful Experience. One felt that designing for maintainability requires common sense and knowledge of the field being supported. He felt too many inexperienced people have never worked in the field or understood the human factors involved.

3. Inability to Acquire Assistance. Several mentioned that the lack of real assistance from the AFALC staff prevented the development of more R&M initiatives since it took the DPMLs' staffs longer to become proficient.

4. Funds Control. Three stated that the DPMLs' failure to understand the funding process, tracking of funds, or availability of depot funds has caused many initiatives to be dropped needlessly for lack of funds. Likewise, they felt the DPMLs failed to properly coordinate with AFLC, AFSC, Air Staff, and other organizations for initial spares funding and other available sources.

5. Contractor Issues. Two contractor related constraints were:

5.1 Organization Structure. Five suggested that unless a contractor's organization is conducive to the achievement of R&M objectives, the program is much harder to manage.

5.2 Failure to Challenge. Two mentioned that DPMLs are often awed by contractors which becomes a psychological constraint. Because contractors wear a coat and tie, the military personnel often think the contractor knows more and accept things without challenging them.

6. Policy and Guidance Issues. Three policy related constraints were:

6.1 Conflicting Guidance. Three felt the regulations and directives are ambiguous. In addition, the headquarters guidance from services, commands, and product divisions often conflict.

6.2 Sole Source. Two felt slow approval procedures for sole sourcing hampers and prevents many R&M initiatives in contracts.

Research Question Four

The fourth objective was to organize and present the respondents' perceptions of how to best resolve these identified constraints. First, the solutions to the seven ranked constraints will be presented in the order they are listed on the interview sheet. Then the solutions to the constraints identified in research question three will be presented. The statements below are not exact quotations of the respondents but are summarized and paraphrased as closely as possible by the author.

Requirements Definition

In the rating exercise, the requirements definition factor was the most consistently ranked factor as evidenced by the lowest standard deviations in the exercise. Though the majority of the respondents rated it as the most important constraint, they all agreed that in the last five years the Air Force has improved tremendously in defining the requirements. In fact, some of the respondents that did not offer any solutions said, "we are there". One pointed out that in his program, the requirements definition of manpower constraints also translated to programmed manpower reductions. However, the fear expressed by many was that R&M is only in vogue now and we may not support it with the same consistency in three or four years. Seventeen respondents suggested solutions that fell into three categories: the use of user conferences, earlier use of

baselining logistics issues, and the development of logistics analysis tools.

1. User Conference. Ten respondents suggested the Air Force could improve defining the requirements by establishing an early working conference with the user in order to discuss some important issues before too many critical decisions are made. Most felt the user is really not in a good position to develop the SONS. First, they are naturally reluctant to commit themselves to certain stated needs until they know what is available with respect to technology and other new concepts. Second, since the users are not continually involved in planning new Air Force designs, inexperienced people often unintentionally limit, in the early system documentation, the best intentions of later logisticians. Past statements of need (SONs) have grossly underplanned for the logistical support. Newer concepts such as line replaceable modules, time stress measurement devices, and systems totally integrated to one another must be planned for from the very beginning. The user conference would give logisticians in the user command a forum to receive this guidance in the early requirements process.

Most felt the best timing for this conference would be at the end of the concept exploration study effort but before going to Air Staff for a Program Management Decision. At that time a technical staff made up of R&M

engineers, logisticians, and contractors from the product division, pertinent laboratories, and the likely Air Logistics center would meet with the user. This more experienced group could then revise the statement of need for a more realistic approach to support. In addition, they could outline a proposed maintenance concept to include levels of maintenance, mean time between failures (MTBFs), mean times to repair (MTTRS), deployment support concepts, and other important areas. These could then be transferred later into meaningful R&M factors for designers to work toward. Throughout this period, it would be imperative for the logisticians to work very closely with the engineers. AFLC would have to address what new procedures would be required as well as any additional funding and manning requirements. Though this process could be expensive, all ten of the respondents felt that this early commitment would do more for the logistics effort than larger SPO staffs in later phases trying to work around the original problems.

Several of the respondents stated the current definitions are not stringent enough and this early interface could define more realistic reliability rates that the SPO could provide. Likewise, the conference could provide the users an introduction to new logistics technology they may not have been aware of, yet prevent the quest for items the current technology could not support.

Two respondents pointed out that most system ideas are sold to MAJCOMS by industry representatives. These conferences could show the users other alternatives and emphasize to industries that all program concepts will be competed. In addition, the conference would insure close coordination with the PEMS for reasonable financial limits. This would help to eliminate working various cost options that would not be politically feasible.

2. Baselineing. Four respondents felt the best solution was through establishing the logistics requirements in the early RFPs and not allowing them to be changed without extraordinary upper level coordination. Likewise, they felt the traditional baselineing of the programs should occur earlier, preferably right after Full Scale Development source selection. Similarly, one respondent felt the best solution was to stand tougher on the requirements. He recommended "do or die" tests that will not accept systems that do not meet requirements.

3. Tool Development. Three respondents stated requirements could be defined more clearly if logisticians could develop tools to determine what reliability requirements (ie. 95% or 98%) were really needed. Currently logisticians are unable to state how many more sorties or other operational goals could be achieved with a 2% increase in reliability of a certain system. DPMLs should be able to quantify R&M impacts in terms of

dollars. These tools would also be valuable in determining support required, spares, and life cycle costs. These specific figures would enable DPMLs to have a much stronger bargaining position in tradeoff discussions of cost versus requirements. Though Dynametrics and other simulation models are a start in that direction, academia and staff specialists should cooperate to develop these management tools.

RFP Evaluation Criteria. The majority of the respondents again believed the Air Force has made remarkable improvements in this area during the last five years. In addition, most felt the requirement definition problem was very closely related to evaluating the RFPs. Therefore, many of the recommended solutions could be integrated or combined. Seventeen respondents suggested solutions which were grouped into three areas: use of a source selections cadre, development of better RFPs to the contractor, and continued emphasis on the program directors to be responsive to the logistic issues.

1. Source Selection Cadre. Six respondents suggested that because of several existing conditions, the best way to evaluate logistics issues in RFPs would be to have a trained cadre of logisticians. Some of the points they feel justify this recommendation are as follows. First, the RFP for full scale development occurs when the SPO's logistics staff is very small and does not have sufficient people to evaluate all the areas even if they

were fully capable. Second, the current system tends to prevent experienced source selection personnel from participating a second time when they could provide valuable guidance. Similarly, since this selection process often takes up to six months, when other SPOs are tasked to provide "bodies", there is a tendency to send those who are marginally productive. Third, source selection requires many specific skills that could be better developed and then used more efficiently on a selection cadre team. Specific skills necessary for the logistics people include: the working intricacies of Logistics Support Analysis (LSA), Life Cycle Cost (LCC) Analysis, business strategy, contracting, and lessons learned from past selection committees. In addition, dedicated R&M engineers would be invaluable. Currently, the few DPMLs who have served on source selection boards stated they relied on the AFALC staff for this expertise, but due to timing problems and other reasons, the expertise could not always be counted on. Contractors are aware of the shortage of experienced evaluators and many respondents felt the contractors take advantage of that.

2. Better RFPs to the Contractors. Six respondents recommended that the RFPs be better written so that the contractors can better understand what the Air Force is really requesting. This would include specifying the logistics test results the contractor must demonstrate

at certain milestones. Too often the RFPs request unrealistic or questionable goals which leads contractors to respond with proposals stated in generalities for "buying into contracts" and then later negotiating away the undefinable goals. The RFPs must demand facts and data that the contractor can be made to uphold. Some of the lessons learned from writing RFPs could be transferred through more DPML Conferences (with more time for DPML interaction) and short training courses.

3. Increased Program Director Guidance. Five respondents believed that the best way to weight the logistics issues more heavily in evaluating the RFPs would be through increased emphasis on the Program Directors being accountable for logistics issues. Logistics must be considered as an equal partner to operational performance when the final recommendations are being developed. Similarly, the up channel briefings should require that logistics issues be given this equal weight to performance characteristics.

Logistics R&D. All nine of the respondents that offered solutions for increasing the emphasis on developing and applying logistics technology recommended a few logisticians be placed in the laboratories. The people selected to work in these labs would have to have an engineering background or at least be technically minded, and be trained in knowing where to find funding sources.

The tasks outlined by the DPMLs for these logisticians fell into five areas. First, they would need to need to find the money sources for the laboratories to research various logistics R&D issues. Second, they would have to influence or change the mindset of the laboratory engineers to look at these supportability issues rather than the more exciting performance issues. They might include a tour for the engineers to visit the field to see the problems and understand the issues. Two DPMLs pointed out the R&M engineers are the "black sheep of their community", and until this perception can be changed, engineers will avoid supportability engineering issues. Third, they would need to coordinate and develop yearly "think tank" sessions between the labs, SPOs, and especially the users or MAJCOMs to focus on new areas that are more promising. The follow-on to this would be the development of a prioritized list of logistics R&D projects to compete with the other R&D projects for funding.

Fourth, technology transfers to the SPOs would need to be more visible. Almost all 28 DPMLs and DOLs pointed out there are just too many priority issues competing for the DPML's time for him to explore new technologies. Symposia are interesting but most of the attendees would not need the information based on the phasing of their programs. Therefore, it is important the logisticians in the labs seek out the early programs, learn about them, and

then offer to the applicable DPMLs what technology might be useful. The respondents who had worked with the Air Force Coordinating Office for Logistics research (AFCOLR) had high praises of their help, but very few even knew of the organization.

Fifth, they would need to help direct the DPML in the best ways to incorporate new logistics technology. This may include identifying additional funding sources available outside the SPO's budget. The coordination may identify problems in the project for the Productivity, Reliability, Availability, and Maintainability Program Office (PRAM) to solve in order to reduce support costs. This may also include helping the DPML with the RFP phrasing to motivate contractors to use new technologies or to provide the DPML an Air Force logistics engineer contact to evaluate the contractors' responses.

Organizational Structure. Though this factor was ranked the lowest of all the constraints, it raised probably the most emotional discussions. Overall, most of the respondents felt they were better off with a dual chain of command than directly under the PD and ASD as long as the current upper level emphasis on R&M is maintained. This emphasis, more than anything else, has helped make the DPMLs' jobs easier by forcing the PDs to understand the R&M requirements and work toward their resolution since they will be questioned on them in their Program Reviews. The

DPMLs felt the dual chain offered them additional flexibility to get things done and immunity to challenge the PD. However, most of the DPMLs stated they have never had to use it since a good rapport with the PD was usually enough to resolve most issues. Most felt a closer tie to the PD than to the AFALC chain of command. However, many of the respondents brought up the closely related OER issue. Many were dissatisfied, confused, or frustrated by their OER chain of command. During the course of these interviews a new Air Force policy was announced that all OERs will receive the first of two endorsements from the evaluator's rating official in order to prevent inflated endorsement levels. However, this policy creates much confusion for the DPMLs since for them, this first endorser will be in a completely different rating chain of command. In addition, many felt they worked for the PD but he never signed their OER while others were rated by neither the AFALC nor the product division headquarters. Most agreed that some kind of universal policy or at least a logical set of rules must be established.

Two organizational structure recommendations were initiated almost unanimously by the respondents.

1. R&M Engineers. Twenty-three of the 28 respondents believed the R&M engineers within the SPOs should work directly for the DPML rather than under the engineering section.

2. Staff Assistance. Twenty-four of the 28 respondents felt the AFALC staff should be reduced or their mission redefined. Most stated they had never received any really beneficial assistance from the AFALC staff even though AFALC has many qualified people. They stated that most of their assistance came from personnel from other SPOs, from the ALCs, and from AFLC in that order. The DPMLs stated they were frustrated by the fact they worked long hours with a shortage of personnel, many of them untrained, and desperately needing assistance in certain skills while the staff left at 1630, had the most qualified technicians, and never came down into SPOs to provide real assistance. Most of the DPMLs and DOLs alike stated they were unsure what functions the AFALC staff performed. The degree of dissatisfaction with the staff was clearly the biggest surprise to the researcher during the interviews. Its breadth and intensity exceeded normal organizational "gripping". Obviously, this perception, whether false or true, should be addressed immediately.

DPML Authority. DPML Authority was rated very low in impact and when asked what solutions the respondents felt would help, several had comments but only eleven felt any solutions were even necessary. The general comments tended to fall within two categories: personal skills of the DPML, and the control of logistics funds. Most of the respondents believed that the DPML had enough authority

once he established credibility with the PD through his knowledge of logistics, the total program, and his ability to keep the PD advised of problems. Most felt that once a DPML knows how to present to the PD an R&M initiative in the ways that it will benefit the PD, the DPML will have no more problems with authority. Several stated the PD will often test the new DPMLs before trusting them to speak and act for the SPO. The second topic commonly commented on was whether logistics funds should be "fenced". This is coding and managing separately certain funds so that the PD cannot use those funds on other goals or needs. Though the DPMLs were split on this, most stated it had little bearing in the long run as long as the DPML could identify his needs and get those items on contract early. A few recommended inflating the DPMLs budget estimates of known projects in order to provide financial flexibility for later unknown projects when available funding may be harder to attain. Three solutions were offered for improving the DPML powerbase: first, earlier establishment of the DPML office; second, improving the DPML selection process; and third, quality controlling the existing DPMLs.

1. Earlier Establishment of DPML Office. Several stated that the DPML has the hardest time with authority in the early phases of the program when he could be having the biggest impact on R&M. The reason for this problem is often that the DPML and any technicians he may be

authorized are not being assigned as early as in the other functions, such as engineering. Therefore, it was recommended by eight respondents to assign the DPML earlier and assign to him more and better trained technicians in the concept exploration and demonstration validation phases. This earlier manning would provide the DPML the ability to influence early decisions and to have the capability to conduct the analytical assessments that give the DPML his credibility with the PD.

2. DPML Selection Process. Two recommended the DPML selection process should be more selective and the applicants should be interviewed or approved by product division and AFALC senior officers. This would improve the quality of incoming DPMLs and would improve the image of the position to both the DPMLs and to others in the SPO.

3. Quality Control of DPMLs. One recommended that AFALC monitor more closely the performance of the DPMLs in the SPOs. Currently, if a DPML fails to take the initiative to make any R&M improvements, the AFALC staff is unaware of it and the PD is often insensitive to the logistics matters unless they have a current impact.

Trained Personnel. Ranked as the constraint with the second highest impact, 22 of the 28 respondents offered suggestions for improving the definitely perceived lack of training. Of all the issues, the DPMLs and DOLs spent more time offering specific solutions to the Trained Personnel

question than any other one. As many of them stated, even though Requirements Definition and RFP Evaluation Criteria could really affect R&M initiatives, there has at least been big improvements in those areas in the last five years and the Air Force is working on even more improvements. On the other hand, the overall feeling of the respondents was that the lack of training is getting worse due to the growing demand for specific skills. Therefore, many of them felt a concerted management effort in this area would reap big benefits. As one respondent stated, every DPML must become a dedicated training officer for his people or they will become demoralized and request a transfer. Their suggested solutions fell within four natural groupings: overall management of the career field, development of a comprehensive training program, specific course curriculum needed, and alternatives to reduce the amount of training required.

1. Overall Management of the Career Field. Most of the respondents felt that Acquisition Logistics should become a separate Air Force Specialty Code (AFSC) or at least a distinguishable shredout of only one AFSC by a prefix or suffix. Many stated this would help toward resolving the training problem by first, identifying what individuals are involved with acquisition logistics; second, placing them under one career manager who would be responsible for the professional development of the career field; and third,

allowing one management evaluation team (MET) to determine manning requirements. Many felt that identifying the acquisition logisticians as a separate specialty would help reduce the excessive turnover that is driving much of the training requirements. It is perceived that a lot of the turnover is caused by failure to recognize acquisition logistics as a unique career field that requires specialized skills. Establishing one career manager would allow one source to monitor the career field size, develop a career master plan, and establish a cycle, or natural succession of assignments for career progression that would flow logically. This career flow of assignments would provide DPMLs experience from the ILSO offices, Air Logistics Centers, and other needed background areas depending on the particular SPO. Currently, the DPMLs are being managed by several different career monitors, ie. supply, maintenance, program manager, transportation, logistics, etc., that move them in and out of the acquisition arena without regard to what the other career monitors may be doing to resources situated in the same SPO. Similarly, by having them identified, these skilled individuals could be recalled easier after other assignments. Another advantage several respondents mentioned, would be the increased emphasis to coordinate people's departure assignments to significant acquisition milestones for additional program stability. Though a

difficult policy to enforce, several felt at least the requirement for upper level approval of transfers would reduce much of the needless turnover and training of new people. A few stated that the Air Force does not tolerate the lack of a training program in other AFSCs such as flying and maintenance, yet in acquisition, where millions of dollars are handled in daily transactions, there is no master plan for selecting, preparing or assigning the personnel.

2. Development of a Comprehensive Training Program. Most of the respondents felt that an overall training master plan should be developed and implemented to insure that the new logisticians receive what general courses are needed and that there is a logical flow into follow-on refresher courses. The consensus was that there should be a relatively short pipeline into the SPO consisting of a short course defining their mission, the acquisition organization structures, and what they can expect and should look for in their SPO. Second, the individuals should spend approximately two weeks within their SPOs in order to understand what their job will entail and then attend an acquisition overview course such as the AFIT Systems 100 course. At this point the DPMLs differed on what specific type training courses should be offered, but they all agreed it should be specific training relative to the individual's particular SPO rather than general

education or on areas that may not apply to that SPO's situation.

Some of the respondents were frustrated with the management of training slots. The respondents from the smaller SPOs stated that the training slots are disproportionately given to the large SPOs because they can apply more political pressure to get the slots. No one perceived an orderly process. Some felt that the overall training office should be within AFALC.

3. Specific Course Offerings Needed. Though there were some areas of general agreement, often the training desires of the DPMLs reflected whether they were from large or small SPOs. The large SPOs tended to specialize their people more and thus wanted more specific logistics skills taught. The smaller SPOs tended to want more general overview courses. Both expressed their difficulty in releasing people to attend programs, but the smaller SPOs were affected even more due to their inherent lack of flexibility. Both felt the courses offered should be of shorter duration than those currently offered. Several expressed a desire for some half day and one day courses. They felt this would enable more people to attend. Related to the difficulty in releasing people, several expressed the current courses have too much wasted time in general orientation, welcoming remarks, etc. They felt if handouts and readings could be distributed prior to arrival, the

training time could be put to more effective use. All of the respondents felt moving the Systems 100 course to Randolph AFB was a mistake due to the additional travel time. Some recommended that if the schools cannot increase the number of their courses, maybe the experienced technicians within the SPOs could teach some logistics skills courses. Two advantages would be that first, the material would tend to be taught at a more realistic and practical level and second, SPOs would offer the courses when they are training their own people. Several suggested there should be a close coordination between the SPOs, the overall AFALC training officer, and the school. The training officer should be able to require the specific course offerings and dates based on the SPOs needs. Their needs would be reflective of what acquisition phases they are entering.

Many of the DPMLs expressed what courses they felt were the most important. Most tended to feel the technicians needed about 2/3 emphasis on logistics skills subjects and about 1/3 emphasis on business strategy subjects. They felt the split ought to be about half and half for the DPMLs. The larger SPOs felt they could OJT the logistic skills but needed formal courses for the business acquisition courses. The smaller SPOs felt they needed formal courses for both. In logistics skills, the subjects mentioned most, in order, were: provisioning for supply

and support equipment, logistics support analysis (LSA), technical order management, R&M, Support Equipment Requirement Document (SERD) management, life cycle costing (LCC), tricks of the trade, and quality control of contractors and vendors. Several commented that a checklist approach is needed in the courses to include points of contact and what regulations, directives, and other policies should be referenced. In the business acquisition courses, the subjects mentioned most, in order, were the acquisition process (in actuality versus theory), contracting, program control (to include the various kinds of funds), and business strategy.

4. Alternatives to reduce the Amount of Training Necessary. Various options were proposed to help educate the DPMLs but not require formal training courses. The four options mentioned most were: Pave Tiger or assistance teams, generic checklists, more accessible service contracts, and semi-annual DPML conferences.

4.1 Assistance Teams. Ten of the DPMLs brought up the idea of developing special teams to go into the SPOs when projects require specialized skills. They mentioned five advantages of having teams over the current method of teaching varied groups in classrooms. First, since these specialized skills are often used only once in a program, it is inefficient to try to train everyone in these skills and unrealistic to believe they will learn it well enough

to go back and set up the program without some real problems. Therefore, the teams would reduce the amount of training needed. Second, by going into the SPOs to set up an LSA program or networking chart for example, all the pertinent personnel in that SPO could be instructed on how to maintain the program at one time rather than just the one who got a training slot. In addition, the training would occur when they need it as opposed to when a slot became available. Third, the team's instructions would be tailored for that SPO's specific needs. Fourth, the team concept would have a much better chance of insuring successful implementation of a technique since the team members would have more experience to apply from several projects. Fifth, this would be a more efficient use of manpower in that it would provide the flexibility to insert people into the SPO when implementing a new technique and to remove them when the workload returns to normal. This pool of experienced technicians would be especially important to SPOs during the early stages when their ILSOs are especially undermanned and without experienced people.

4.2 Generic Checklists. Seven respondents advocated using generic checklists to guide the implementation of new techniques. These general checklists would include the best steps for setting up the program, the problem areas to avoid, reference sources, names, phone numbers, and areas of specialties of people they could

contact for help, and lead times to expect in accomplishing these steps. The underlying assumption is that the checklists provide more than a student is going to remember from a classroom course and thus eliminate the need for some formal training.

4.3 Services Contracts. Four respondents suggested that many of the projects could be managed more efficiently through services contracts. They suggested that the firms would already be skilled in establishing the projects, would provide more continuity than the current SPO manning policies provide, and could be held accountable for the quality of their work. They pointed out that the biggest drawback to this solution would be the current guidance policies that require long lead times before awarding service contracts for issues that often have short suspenses.

4.4 DPML Conferences. Two people recommended that semi-annual DPML conferences would be a good way to communicate both up and down the channel the important issues in acquisition logistics. In addition, both felt it would also be beneficial to invite the logisticians from the contractors.

Test and Evaluation. Only 13 of the respondents offered any recommended solutions to this constraint. Most of the respondents admitted they had little or no experience working with test and evaluation and wished they

knew more about it. Of the comments received, most fell within three categories: preparing the statement of work, managing the program, and working with the Air Force Operational Test and Evaluation Center (AFOTEC).

1. Preparation of Statement of Work. The majority of the respondents indicated that the most important issue was clearly identifying in the statement of work the R&M specifications the contractor should demonstrate. The DPML must also establish test data points. To further insure the contractor fulfills these testing specifications, the contract should contain significant penalties for failures and incentive bonuses (particularly the ones that designate some of the bonus to the contractor's logistics personnel) for surpassing the specifications. Seven of the DPMLs stated people experienced in test and evaluation should be coordinated with during the development of the RFP and SOW. They suggested both the assistance teams mentioned earlier and AFOTEC as the best sources of expertise.

2. Management of the Program. Once the SOW is completed, five DPMLs remarked on the importance of attaining dedicated resources from the PD. They stated the trend that program review briefings have started questioning PDs on what specific testing data has been accumulated has helped the DPMLs more than anything else. A few also recommended that DPMLs be educated to coordinate as early as possible for dedicated testing times,

conditions, and places for the logistics tests. The tests should resemble the expected operational environment as much as possible. In addition, two stated that AFOTEC has a tendency to place all logistics tests in the undesirable hours. This tends to discourage the opportunity of having key personnel attend these events. DPMLs must also be educated to limit the contractors as to what conditions, additional supplies, and personnel they use to influence the tests. Testing and Evaluation checklists and lessons learned are essential to alert the DPMLs of these and other possible pitfalls.

3. AFOTEC Working Relations. Four respondents stated that AFOTEC needs to maintain its independent role but not to the degree that it cannot help the SPOs. These four felt AFOTEC often perceives of itself as the IG and only critiques the SPOs after test dollars have been wasted rather than helping the SPOs prepare and avoid mistakes. However in contrast, two stated that AFOTEC had served on their SPO team to establish testing procedures and had helped solve several problems.

Suggested Solutions to Respondent Generated Constraints

Research question three identified 15 constraints that the respondents initiated. Though some of their constraints and solutions overlap with the original seven already covered, Table VIII summarizes the suggested solution each respondent gave following their perceived constraint.

TABLE VIII

Suggested Solutions to Respondent Generated Constraints

<u>Constraint</u>	<u>Solution</u>
1. PD interest in R&M issues	Continued emphasis by upper level management to hold the PDs accountable for the R&M issues during their program review briefings.
2. Manpower Authorizations	One Management Engineering Team (MET) needs to be in charge of determining manning authorizations and one personnel office in charge of filling the justified slots.
3. Manning Continuity	Freeze assignments of both civilian and military personnel to milestones or project completions. This would provide continuity and help insure that important management initiatives are fully carried out and managers are held more accountable for their actions. Senior officers could review and waiver any early moves.
4. Assignment of R&M Engineers	R&M engineers should work directly under and be evaluated by the DPML. Their duty location should depend on the SPO, but either be collocated with the design engineers or in the DPML office.
5. Manning of Basket SPOs	Basket SPOs should be evaluated before assigning inexperienced people to them. The majority of the inexperienced should be assigned to the larger SPOs which are more capable of training them.
6. ALC Support	AFLC and the ALCs must take a more active role in the early acquisition phases to ensure contractors are providing supportable and supported systems. The excuse of lacking TDY funding is not justified in comparison to the value of early expertise.

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ACQUISITION LOGISTICS CONSTRAINTS AND RECOMMENDED
SOLUTIONS: PERCEPTIONS O (U) AIR FORCE INST OF TECH
WRIGHT-PATTERSON AFB OH SCHOOL OF SYST R F BAYLESS
SEP 85 AFIT/GLM/LSM/855-4 F/G 15/5

2/2

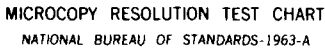
UNCLASSIFIED

NL

END

FILMED

DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TABLE VIII (continued)

<u>Constraint</u>	<u>Solution</u>
7. Logistics Experience	Acquisition logisticians should have first completed some form of logistics assignment (preferably with a system similar to the SPO's product) before being assigned to the SPO. Once in the SPO, the product divisions should use TDYs, briefings, or other forms to keep the logisticians familiar with the product and its intended environment.
8. Lack of Real Staff Assistance	AFALC senior officers need to encourage their staff specialists to work with SPOs requesting assistance for projects requiring specific skills. They should stay in the SPO for however long it takes to get the project going, thus becoming committed to its success.
9. Funding Sources	DPMLs should be either taught through a symposium or checklist type document what types of funds are available, how to acquire them, and which documents are available to track funds.
10. Contractor Organization Structure	DPMLs and PDs must insure the contractor's logistics and engineering offices maintain equal status and that there is good communication between them. Starting at the guidance conference, the DPML and PD must demonstrate to the contractor they expect equal emphasis to be placed on logistics issues. This will aid the contractor's logisticians and will heighten the company's perceptions of their ideas and status.
11. DPML Assertiveness	Program Directors and DOLs need to insure that their DPMLs do not accept everything a contractor states and that the issues are actively challenged by the DPMLs.

TABLE VIII (continued)

<u>Constraint</u>	<u>Solution</u>
12. Conflicting & Confusing Guidance	A "task force" should be established to tailor re-define, and update DOD, Air Force, AFSC, AFLC, AFALC, and product division regulations, directives, and policies concerning acquisition and logistics. In addition, provisions for innovative techniques should be allowed rather than foregoing cost savings due to paperwork requirements.
13. Sole Source Requirements	DOD should ease sole sourcing requirements or streamline the procedures in order that cost saving R&M initiatives can be implemented into contracts expeditiously.
14. Different Leadership Perspectives	Policy letters and other forms of communication to the SPO personnel should be more in the form of a coordinated agreement between either AFLC and AFSC, or AFALC and the product divisions.
15. Management of Joint Programs	Though it may be tough politically, the Air Force should baseline all joint programs and then place each program under one service using only that service's procedures. Having only one service manage a program will result in both cost and time savings.

V. Conclusions and Recommendations

During the development of this research project, it was assumed that the DPMLs and DOLs of the major programs would have had more DPML experience and experience during the early acquisition phases than they did. Because a few had never worked with any program during its concept exploration, demonstration validation, or early portions of full scale development, these individuals had difficulty in providing specific recommended solutions to factors such as Requirements Definition and RFP Evaluation Criteria. However, the researcher feels this had little effect on the rating results or other recommendations for three reasons. First, the statistical tests performed showed little difference in the ratings of the experienced and less experienced. Second, most programs had several on-going modifications and changes that allowed the DPMLs to experience to a degree many of the same steps and frustrations of programs in the early phases. Third, being on the end of a program often allows one the advantage of hindsight and to understand what should have been done earlier in the program's life. Overall, the researcher believes the ratings and recommended solutions presented are valid and present a formally organized assessment of what the major R&M advocates in the program offices feel are the major problems and what corrective actions should be taken.

Research Question One

The first objective was to identify "How do the DPMLs rank order seven major constraints as to their impact on impairing the DPMLs' ability to influence a system's design for improved supportability?"

The factors were rated by the respondents on graphic rating scales and then ranked by their mean measurements on the scales. The overall ranking of each factor was very consistent within all three experience level groupings of the respondents. In addition, the mean measurements of all the factors were clearly separated thus making distinctions between rankings very definite.

The rankings, as depicted in Table IV, closely resembled the results of the Hull and Lockhart Study in 1982. Though some of the factors rated in that study were different and the similar ones were phrased differently, there were close similarities showing a consistency over time of the DPMLs' perceptions. The Hull and Lockhart study rated Logistics Design Goal Definition, which was defined similarly to Requirements Definition, also as the number one factor. Their study rated Goal Conflict, defined similarly to RFP Evaluation Criteria, as the second factor; RFP Evaluation Criteria was ranked third in this study. Conversely, their study rated Logistics Skills, defined similarly to Trained Personnel, as third while it was rated second in this study. This study tended to rate the lack of DPML

Authority relatively lower than in the previous study which probably reflects the increased emphasis R&M issues have received from senior officers in the last three years. Though the ratings of the two studies cannot be compared directly due to the differences in the two studies, the overall similarities tend to strengthen the statistical analyses in this study.

The researcher believes the rankings accurately represent the impact of the factors as perceived by the DPMLs and DOLs of major weapon systems.

Research Question Two

The second objective was to identify; "Do the DPMLs significantly differ in their perception of the rank ordering of the seven constraints by product division?"

The ratings of the DPMLs and DOLs of the major systems within ASD and ESD were compared. Statistical tests at the .05 significance level were performed comparing all three experience level groupings within the two product divisions. There were no statistically significant differences in any of their ratings. As shown in Table VI, the rankings of all the respondents differed only slightly between the two product divisions by the reversal of the DPML Authority and Test and Evaluation factors for the fifth and sixth positions.

The researcher believes that because of the lack of any statistical differences between the two product divisions,

regardless of experience levels analyzed, it can be reasonably assumed that there are no statistically significant differences in the perceptions of the DPMLs of any of the product divisions.

Because of the differences in experience levels, statistical tests were also conducted to identify if any of the other demographic categories differed significantly in their ratings. The results showed rank, time as a DPML, or early/late acquisition experience had little bearing on the rankings. The comparison of those with less than three years in acquisition versus those with more, however, showed the less experienced rated the factor of DPML Authority significantly higher and Test and Evaluation much lower than the more experienced respondents. There was also an overall tendency that the more experienced and those with early acquisition phase backgrounds to place more emphasis on trained personnel.

Research Question Three

The third objective was to identify, "What other constraints do the DPMLs perceive as significant?"

Fifteen additional constraints were identified and grouped into six areas: Program Director priorities, manning, lack of assistance, funds control, contractor related, policy and guidance, and management procedures of joint programs. These constraints are described in Chapter IV. The majority are derived from the overwhelming

consensus that the Acquisition Logistics career field needs to be managed separately. They provide a good "snapshot" view of what additional constraints were on the minds of the DPMLs on the days they were interviewed.

Research Question Four

The fourth objective was to identify, "What various solutions do the DPMLs propose to reduce the impacts of the constraints in questions one and three?"

The recommendations were summarized and paraphrased as closely as possible. Soliciting the recommendations took the largest percentage of time during the interviews and also in presenting the results. However, they provide the greatest opportunity for applied value. Though only a few may have mentioned some solutions, it is not inferred that the others did not agree, but that they merely may not have thought of it at the time.

As could be expected, the interviewer improved during the course of the interviews in his ability to administer the interviews and in his understanding of the subject matter. The likely result of this learning process was that better recommendations were gathered from the later interviews. It was not in the scope of this research to evaluate the recommended solutions. However, it appears some recommendations such as the development of user conferences, the development of management tools to operationalize reliability figures, the development of a

source selection cadre, the assignment of DPMLs to laboratories, changing the control of R&M engineers, establishing a separate management of the career field and its training requirements, development of assistance teams for specialized skills, and the use of generic checklists show definite promise.

Recommendations

The researcher offers two recommendations for further study based on the findings of this research. First, reaccomplish this study in a few of the acquisition organizations within the Army and Navy. Though this study could be generalized to be representative of all Air Force product divisions, it would be important to discover if the same issues are significant in the other services. If not, what procedures are being used. If the same problems are evident throughout the DOD, the organizational level responsible for initiating a resolution will be different.

A second recommendation would be for further research to be conducted on the recommended solutions offered by the respondents. Each recommendation should be researched to see how much, if any, additional funding, manning, and other resources would be required, their feasibility, and compare these costs to what additional benefits could be logically expected. Those recommendations which prove to be feasible and cost effective should be briefed to the appropriate staff for recommended implementation.

Appendix A: Interview Form

SURVEY INFORMATION SHEET

Hypothetical Case

The Air Staff is interested in finding out what the DPMLs believe are their most significant constraints in implementing Reliability and Maintainability into new weapon system designs. Therefore, they developed a list of possible factors which may be contributing to the problem. They have asked you to apply your personal experience and professional judgement to help them determine the order of significance of these 7 factors.

Instructions

1. Please read the entire list of factors before rating the impact of any of them.
2. Select the factor you feel has the MOST IMPACT, mark it on the scale, and place the letter of the factor next to the mark. (Note the scale will allow you to rate not only the order of the factors, but also the difference in significance by their relative position on the scale.)
3. Continue rating the factors until you have marked all of the factors on the scale.
4. If you feel two or more factors are equally important, use a single mark, but please be sure all letters are accounted for.

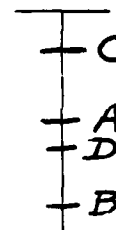
Example of Rating Process: What is the relative impact of these factors on your personal budget?

- A. Car-Loan
- B. Entertainment Expense
- C. Home Mortgage
- D. Groceries

HIGH IMPACT

SOME IMPACT

LOW IMPACT



SURVEY ANSWER SHEETS

Personal Data

1. What is your present grade?
 - A. 0-1 to 0-3
 - B. 0-4 to 0-5
 - C. 0-6 or higher
 - D. GS-9 to GS-12
 - E. GS-13 to GS-14
 - F. GS-15 or higher
2. What is the total time you have worked in system acquisition?
 - A. Less than one year
 - B. One or two years
 - C. Three to five years
 - D. More than five years
3. How long have you worked as the DPML in a SPO?
 - A. Less than 6 months
 - B. Six months to 1 year
 - C. One to 2 years
 - D. More than 2 years
4. How long have you worked as a DPML in programs during their early concept exploration or demonstration validation phases?
 - A. Less than 6 months
 - B. Six months to 1 year
 - C. One to 2 years
 - D. More than 2 years
5. In which product division are you assigned?
 1. ASD
 2. ESD

CONSTRAINTS TO IMPLEMENTING R&M INITIATIVES

- A. REQUIREMENTS DEFINITION: Inadequate definition of logistics design parameters in early program documentation. (Includes such issues as ambiguous statements of need and the difficulty of defining specific logistics goals in early program plans and constrast statements of work.)
- B. RFP EVALUATION CRITERIA: Inadequate weighing of logistics issues in evaluating RFPs. (Includes such issues as the composition of the source selection committees, failure to convince contractors that R&M issues are equal to cost and performance issues, lack of award fee contracts on R&M issues, and the reluctance to give more weight to proposals with innovative approaches to supportability.)
- C. LOGISTICS R&D: Insufficient emphasis on developing and applying logistics technology. (Includes such issues as the lack of communication from the Coordinating Office for Logistics Research and Development and the Logisitics and Human Factors Division of the Human Resources Laboratory.)
- D. ORGANIZATIONAL STRUCTURE: Dual chain of command splits DPML loyalty. (Includes such issues as inhibiting DPMLs from being part of the logistic and acquisition teams, and inhibiting communications with the SPO and logistic agencies.)
- E. DPML AUTHORITY: The lack of delegated or assumed decision making authority. (Includes such issues as control of logistics fund expenditures and the ability to influence design trade-off decisions when there is a conflict with performance oriented goals.)
- F. TRAINED PERSONNEL: Failure to employ experienced and trained logisticians. (Includes such issues as being assigned mostly inexperienced personnel officers, rapid turnover, and the lack of meaningful training in LSA, acquisition strategies, incentives, R&M issues, and systems analysis.)
- G. TEST AND EVALUATION: Inadequate T&E for supportability. (Includes such issues as planning, funding, testing based on operational requirements, early testing under realistic conditions, and clear definition of government and contractor responsibilities.)

All factors will be ranked on this one scale. Please indicate your feelings about the impact each listed factor has on R&M in a hypothetical program office. Make sure each hash mark is identified by the letter of the factor it represents.

SIGNIFICANT IMPACT

SOME IMPACT

LOW IMPACT



1. What other factors do you consider significant?
2. If you were "Chief of Staff for a day," what solutions would you propose to lessen the impact of the seven measured constraints and any of the above factors. Please be as specific as possible by identifying action agencies, and other pertinent details.

Appendix B: Data Inputs From Respondents

Below are the data inputs for groups one, two and three. Group one contains all the responses while groups two and three are just the more experienced respondents from group one. Each line signifies the responses of one interview. The first five digits are the answers to the demographic questions. The next seven groupings are the measurements, in millimeters, of each respondent's ratings of the factors from the graphic rating scale.

54412	59	39	33	10	17	71	28
21222	59	54	50	34	47	59	44
13112	80	44	19	35	14	64	54
21112	69	55	47	12	23	19	35
54212	74	15	35	10	30	69	42
54442	73	75	15	06	06	45	70
23432	75	50	22	04	31	50	68
22222	75	41	59	25	64	58	11
54212	77	40	59	04	40	62	30
22332	62	67	33	41	12	79	17
54332	55	51	47	10	06	73	40
54442	72	75	04	32	53	61	14
24111	72	50	23	12	19	39	72
33441	75	51	55	01	15	71	25
24441	73	53	11	47	15	45	40
22311	67	73	44	13	58	78	48
23311	71	43	45	57	54	79	20
33321	17	14	45	71	68	11	43
34411	77	79	25	05	55	54	43
24211	60	55	50	12	04	72	17
54431	55	53	50	21	73	59	39
22211	55	52	08	13	70	24	15
22211	41	47	55	19	48	55	23
54431	53	12	50	10	34	77	07
22231	57	51	72	07	52	57	13
24441	41	45	02	23	10	77	50
34441	77	35	70	53	17	80	49
24411	70	54	51	08	14	75	24

12.13.51.JCLP, CA, N1706H3,

Group Responses

54412	59	39	33	13	17	71	22
54442	73	56	16	06	06	45	70
23432	76	60	22	04	31	50	58
54332	55	51	67	19	06	73	40
54442	72	76	04	32	53	61	14
33441	76	61	66	01	15	71	26
24441	73	63	11	47	15	46	40
23311	71	43	45	57	54	79	20
33321	17	14	45	71	68	11	45
34411	77	79	26	06	65	54	43
64431	66	63	59	21	73	59	38
54431	53	12	50	15	34	77	07
24441	41	46	52	23	10	77	60
34441	77	35	70	53	17	80	49
24411	70	64	01	08	14	75	24

12.14.02.UCLP, CA, 0170643,

Group Two Responses

54442	73	56	16	06	06	45	70
23432	76	60	22	04	31	50	58
54332	55	51	67	19	06	73	40
54442	72	76	04	32	53	61	14
33441	76	61	66	01	15	71	26
24441	73	63	11	47	15	46	40
64431	66	63	59	21	73	59	38
54431	53	12	50	15	34	77	07
24441	41	46	52	23	10	77	60
34441	77	35	70	53	17	80	49

12.14.24.UCLP, CA, 0170643,

Group Three Responses

Appendix C: SPSS Program Code

RUN NAME	THESIS
PRINT BACK	CONTROL
VARIABLE LIST	Q1 TO Q12
INPUT MEDIUM	CARDS
N OF CASES	UNKNOWN
INPUT FORMAT	FIXED(5F1,1X,7F3.1)
VAR LABELS	Q1,GRADE/Q2,TIME IN ACQ/Q3,TIME AS DPML/Q4,TIME IN CE OR DV/Q7,RFP EVAL CRITERIA/Q8,LOGISTICS R&D/Q9,ORGAN. STRUCTURE/Q10,DPML AUTHORITY/AL/ Q1 TO Q12(0)
MISSING VALUES	GENERAL=Q1 TO Q5
FREQUENCIES	3,8
OPTIONS	ALL
STATISTICS	
READ INPUT DATA	
T-TEST	GROUPS= Q5/VARIABLES=Q6 TO Q12/
ONEWAY	Q6 TO Q12 BY Q1(1,6)
ONEWAY	Q6 TO Q12 BY Q2(1,4)
ONEWAY	Q6 TO Q12 BY Q3(1,4)
ONEWAY	Q6 TO Q12 BY Q4(1,4)
*RECODE	Q1 (2=1) (3=2) (4=1) (5=1) (6=2)
T-TEST	GROUPS=Q1/VARIABLES=Q6TO Q12/
*RECODE	Q2(2=1) (3=2) (4=2)
T-TEST	GROUPS=Q2/VARIABLES=Q6 TO Q12/
*RECODE	Q3(2=1) (3=2) (4=2)
T-TEST	GROUPS=Q3/VARIABLES=Q6 TO Q12/
*RECODE	Q4(2=1) (3=2) (4=2)
T-TEST	GROUPS=Q4/VARIABLES=Q6 TO Q12/
13.19.54.UCLP,CA, N1706H3,	0.176KLNS.

Appendix D: Sample Statistical Test For Evaluating Each Factor Between ASD & ESD

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
Q9 ORGAN. STRUCTURE				
GROUP 1	16	23.9375	21.019	5.255
GROUP 2	12	18.5833	13.747	3.969

POOLED VARIANCE ESTIMATE					SEPARATE VARIANCE ESTIMATE		
F	2-TAIL	T	DEGREES OF	2-TAIL	T	DEGREES OF	2-TAIL
VALUE	PROB.	VALUE	FREEDOM	PROB.	VALUE	FREEDOM	PROB.
<u>2.34</u>	.160	<u>.77</u>	26	.450	.81	25.62	.424

The above portion of the computer printout demonstrates the statistical analyses performed on each of the seven rated factors when compared between ASD and ESD. Following is a sample of the statistical tests the researcher performed on each of the seven factors using the computer information. This particular sample showed there was no significant statistical difference in the ratings given by the ASD respondents, group one, when compared to the ESD respondents, group two, concerning the rated factor, Organization Structure.

$$H_0: \sigma_1^2 = \sigma_2^2$$

$$H_a: \sigma_1^2 \neq \sigma_2^2$$

Reject if $F > F_{\alpha/2}$

$$2.34 > 3.33$$

Reject H_0 : Use Pooled
Variance

$$H_0: \mu_1 = \mu_2$$

$$H_a: \mu_1 \neq \mu_2$$

Reject if $t > t_{\alpha/2}$

$$.77 < 2.07$$

Do not reject H_0 :
No Significant Difference

Appendix E: Sample Statistical Test For Evaluating Demographic Category

VARIABLE Q8 BY Q4		LOGISTICS R&D TIME IN CE OR DV			
ANALYSIS OF VARIANCE					
SOURCE		D.F.	SUM OF SQ.	MEAN SQ.	F RATIO F PROB
BETWEEN GROUPS		3	1307.875	435.958	<u>1.012</u> .4045
WITHIN GROUPS		24	10335.090	430.629	
TOTAL		27	11642.964		

THESIS 85/08/01. 13.43.35. PAGE 45

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VARIABLE Q9 BY Q4		ORGAN. STRUCTURE TIME IN CE OR DV			
ANALYSIS OF VARIANCE					
SOURCE		D.F.	SUM OF SQ.	MEAN SQ.	F RATIO F PROB
BETWEEN GROUPS		3	2081.352	693.784	2.441 .0889
WITHIN GROUPS		24	6821.077	284.212	
TOTAL		27	8902.429		

The above portion of the computer printout demonstrates the statistical analyses performed on each of the seven factors by each of the four demographic categories of grade, time in acquisition, time as a DPML, and time in the early acquisition phases. This particular sample tests the variance is in responses to how logistics R&D and Organizational Structure were rated between each early acquisition experience level and within each of those experience levels. Below is the statistical test the

researcher performed on each factor using the computer information.

Reject if $F > F_{.05}(v_1, v_2)$

1.012 $\nmid$ 2.8

Do not reject: No Significant Difference.

Appendix F: Sample Statistical Test For Evaluating
Each Factor By Experience Levels

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR
Q8 LOGISTICS R&D				
GROUP 1	23	41.3043	21.074	4.394
GROUP 2	5	53.4000	17.827	7.972

POOLED VARIANCE ESTIMATE					SEPARATE VARIANCE ESTIMATE		
F VALUE	2-TAIL PROB.	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
<u>1.40</u>	.819	<u>-1.19</u>	26	.245	-1.33	6.69	.226

The above portion of the computer printout demonstrates the statistical analyses performed on each of the seven rated factors when comparing the less experienced in each demographic category, or group one, to the more experienced respondents, or group two. This particular sample is comparing the responses to the Logistics R&D factor by those with less than three years in acquisition with those with three or more years. Below are the statistical tests the researcher performed on each factor using the computer information.

Reject if $F > F_{\alpha/2}$

1.4 > 8.53

Use Pooled Variance

Reject if $t > t_{\alpha/2}$

-1.9 < -2.056

No Significant Difference

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VITA

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Over the last five years, significant actions have been taken by upper management levels to emphasize the importance of designing into new weapon systems a higher degree of reliability and maintainability. To further these efforts, research was needed to first, measure the significance of specific constraints impacting the "front line" initiators in the process, namely the Deputy Program Managers for Logistics (DPMLs), and second, to identify their recommended solutions to these constraints.

A literature review of what senior officials felt were problems in achieving R&M initiatives was developed into a list of seven acquisition logistics constraints. The list was then evaluated through personal interviews with the DPMLs and Directors of Logistics (DOLS) of the major programs within Aeronautical Systems Division (ASD) and Electronic Systems Division (ESD).

The respondents ranked the factors on a graphic rating scale and provided additional constraints they believed impacted their mission. Statistical tests showed a clear consensus by the respondents of the rank ordering of the seven constraints. In addition, there were no significant differences in the rankings by the two product divisions and few statistical differences between the respondents regardless of their rank or experience level.

To enhance the applied value of the research, the majority of the interview time was used collecting what the DPMLs perceived as the best solutions to these constraints. Their comments were candid and their 37 recommendations deserve further study, in that they were offered by the people who work closest to the logistics acquisition problems.

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