



FILE COPY.

200

79-200 tu

A STUDY OF THE MANPOWER PLANNING AND ALLOCATION PROCESS OF THE UNITED STATES AIR FORCE LOGISTICS COMMAND

#### A Thesis

Presented in Partial Fulfillment of the Requirements for the Degree Master of Science

by

Kendall Carl Rogers, B.S.I.E.

The Ohio State University 1979



Approved by

Department of Industrial and Systems Engineering

10 16 093

DISTRIBUTION STATEMENT A Approved for public release; Distribution Unlimited

UNCLASS ITY CLASSIFICATION OF THIS PAGE (When Date Entered) **READ INSTRUCTIONS** CT-REPORT DOCUMENTATION PAGE BEFORE COMPLETING FORM 2. GOVT ACCESSION NO. 3. RECIPIENT'S CATALOG NUMBER 91417 79**–20**0T TYPE OF REPORT & PERIOD COVERED TITLE (and Subtitle) A Study of the Manpower Planning and Allocation Thesis Process of the United States Air Force Logistics Command . 6. PERFORMING ORG. REPORT NUMBER 8. CONTRACT OR GRANT NUMBER(+) 7. AUTHOR(a) 10 Kendall Carl/Rogers Mas ALS PERFORMING ORGANIZATION NAME AND ADDRESS PROGRAM ELEMENT, PROJECT, TASK AFIT Student at: The Ohio State University 1 11. CONTROLLING OFFICE NAME AND ADDRESS 12. REPORT DA 979 Summer AFIT/NR 13. NUMBER OF WPAFB OH 45433 86 14. MONITORING AGENCY NAME & ADDRESS(If different from Controlling Office) 15. SECURITY CLASS. (of this report) UNCLASS 154. DECLASSIFICATION/DOWNGRADING 16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribtuion unlimited 17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) APPROVED FOR PUBLIC RELEASE AFR 190-17. 23 SEP 1980 FREDRIC C. LYNCH, Meint USAF Director of Public Affairs 18. SUPPLEMENTARY NOTES IAW AFR 190-17 Approved for public release: Air Force Institute of Technology (ATC) Wright-Patterson AFB, OH 45433 19. KEY WORDS (Continue on reverse side if necessary and identify by block number) 20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Attached UNCLASS DD 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLET 122 SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

#### ACKNOWLEDGEMENTS

I would like to thank my adviser, Dr. George L. Smith, Jr., for his aid and counsel in the preparation of this study and for allowing me to perform a study that is related to my future employment with the United States Air Force and to Dr. Al Bishop for serving on my oral defense committee.

I would also like to thank Colonel George S. Robertson, III, Director, Manpower and Organization, Deputy Chief of Staff/Manpower and Personnel, Headquarters Air Force Logistics Command and his staff for providing pertinent data required for this report, the personnel of the Acquisition Division at the Sacramento Air Logistics Center, for information needed for the case study, and Miss Becky Sikora for being patient while typing the rough draft and the final copy.

Accession For NTIS GDA&I DDC TAB Unannounced Justification By\_ Distribution/ Codes Avail and/or Dist special

ii

#### THESIS ABSTRACT

THE OHIO STATE UNIVERSITY GRADUATE SCHOOL

 NAME
 Kendall Carl Rogers
 DEGREE
 M.S.

 DEPARTMENT
 Industrial and Systems Engineering

 TITLE OF THESIS
 A Study of the Manpower Planning and

 Allocation
 Process of the United States Air Force Logistics

 Command

The planning for and allocation of human resources in the private and public sector is an important function of all entities within these sectors. This study presents a detailed look at the process employed by the Air Force Logistics Command in allocating manpower resources when new work loads are undertaken. New work loads are normally generated as a result of weapon system acquisition and the impact of the acquisition is examined through a case study of the A-10 weapon system. A new approach for allocating manpower that is related directly to weapon system opera-

tion is proposed.

ser's Signature

Summer - 1979 - Year

# TABLE OF CONTENTS

1

**A**bamban

ومركافتهم والأقام أستمام كمساحة لحاميهم والمحالية والمتحالية والمسابك حمالتي والمتحاكم متشاعله

Chapter		raye
Ι.	INTRODUCTION	. 1 . 2 . 5 . 6 . 7
11.	MANPOWER PLANNING AND ALLOCATION CONCEPTS The Private Sector	9 9 11 13 28 36
111.	ANALYSIS OF MANPOWER PLANNING AND ALLOCATION FOR THE A-10 WEAPON SYSTEM ACQUISITION The A-10 Acquisition Cycle Air Force Logistics Command Manpower Planning and Allocation During	N 45 46
	Acquisition The Program Management Responsibility Transfer Requirements The A-10 Integrated Logistics Support Plan Summary and Conclusions	. 48 . 55 . 56 . 60
IV.	MANPOWER ALLOCATION MODEL	63 63 72 73
<b>v.</b>	SUMMARY AND CONCLUSIONS	. 75 . 75 . 77 . 78
APPENDIX	•••••••••••••••••••••••	. 80
BIBLIOGR	АРНУ	. 86

iii

# Chapter I INTRODUCTION

In the management of modern day business activities, both in the private and public sector, one of the most important resources that must be properly utilized is manpower. A distinct difference can be noted between the two sectors. In the private sector, management (within certain limits) has the capacity to hire the manpower resources necessary to produce goods or provide services as deemed necessary to conduct a successful business enterprise. On the other hand, government agencies (whether at the local, state, or national level) can only hire those manpower resources for which an approved budget, paid for by the taxpayer, can bear. In the public sector, the production of goods is generally nonexistent but the providing of services to the taxpayer is the main business for which it is engaged. This paper is an attempt to analyze the manpower resources used by one segment of the public sector with emphasis placed on the allocation of limited manpower resources to a vast network of support services.

#### Nature of the Study

For study of a public entity at any level, the selection should be one which is complex enough to be of interest, but simple enough to be understood and analyzed. For instance, city government could be chosen since the average city provides services in the areas of police and fire protection, garbage collection, water service, park and recreation, etc. At the state level, in transportation alone, services for highway maintenance, automobile registration, drivers' licenses issuance, and assorted other services are demanded by the public. While the hiring and allocation of human resources for these activities should be dictated by crime rates, state of repair of roads and highways, budget constraints may prevail.

At the national level, the problem is even more complex. Budgeting for social programs versus defense expenditures is debated endlessly. However, nearly all citizens are concerned that adequate national defense be provided at the lowest cost possible. The government agency charged with the responsibility of providing this defense is the Department of Defense. Within the Department of Defense, the Air Force, Army, and Navy are charged with providing the necessary manpower to carry out the defense effort. With the conclusion of the Viet Nam

war, these agencies have seen a decline in manpower resources both as a result of manpower available and Congressional limitations placed on the agencies as to the number of personnel that can be employed at a given time. As a result of the continual purchases of defense hardware such as aircraft, tanks, and ships, one of the most important aspects of national defense is the support requirements that are necessary to maintain the hardware in operational ready status in the event it becomes necessary to deploy the forces in time of war. It is this aspect of utilization of human resources that appears to be most affected when manpower resources are funded by Congress. This is due to the fact that the systems' operators are considered the most important when manpower allocations are levied. It does not make sense to buy an aircraft and not allocate personnel to pilot the vehicle; it apparently makes sense not to support it.

For instance, the Air Force Logistics Command is charged by the Department of the Air Force with providing the necessary support to the operating commands in the areas of depot maintenance, supplies, war reserve materials, equipment repairs, and a host of other services necessary to keep the Air Force aircraft that are in the inventory at peak operating capability. The assigned

manpower strength of this command as of 30 September 1978 was 91,605. The total United States Air Force manpower assigned as of this date was 796,808. This means that a mere 11% of the total Air Force population is allocated to the support role. It should be noted, however, that this support does not include the active duty personnel assigned to the operating units at base level.

Within this support arena, the cost of manpower represents perhaps more than 50% (York, 1975) of the cost of maintaining the weapon systems over their life. Thus, it becomes necessary to efficiently utilize the allocated manpower in an effort to maintain the support required at the lowest possible cost.

As in the selection process for any type of study, one consideration that influences the area of concentration is the availability of data. As stated above, another criterion for selecting a public entity for study involves the complexity of the services provided. For this study, the manpower allocation process for the Air Force Logistics Command has been chosen as the entity to be analyzed. This choice was made based on the two factors stated: first, data were accessible and readily available; and secondly, the nature of services is sufficiently complex.

# The Importance of the Problem

New weapon systems are constantly being acquired in an effort to provide updated and modern weapon systems, and to provide for an advanced state of defense. Since new systems are usually state-of-the-art and in most cases are somewhat more complex than their predecessors, the support requirements increase steadily. Concurrent with this increase in support requirements, we are faced with a decrease in manpower resources. Consequently, the efficient and effective allocation of these resources becomes extremely important. This is complicated by the fact that the new systems are costing more while the Congressional emphasis is in cutting defense cost. Thus, manpower resources will continually decrease since over 50% of the support cost is in the area of manpower. Decline can be offset only if an effective manpower allocation system is used.

It might be concluded that, since new updated systems are continually entering the inventory, older systems are being eliminated. This is partly true. A replaced system normally is assigned to the Air Force Reserves or National Guard units. The Air Force Logistics Command, however, is still responsible for providing support for these systems. However, there are systems that are removed

completely from the inventory. These are normally systems that have been operated by the Reserve and Guard units. This means that when a new system enters the inventory, the support for that system will require a certain level of manpower but the overall Air Force Logistics Command increased requirements will be less than the new system requirements since some manpower will be shifted from the outgoing system to the new system.

In addition to direct or primary manpower allocations, the planning for total manpower during the acquisition process must include support manpower.

### Objectives of the Study

As stated in the previous section, effective allocation of manpower is paramount since that resource is on the decline. This study will focus on the current manpower allocation process as employed by the Air Force Logistics Command and will provide a descriptive model of this process. The process of weapon system acquisition will be discussed in relation to manpower requirements during the acquisition cycle. The primary vehicle for the analysis is a case study.

As an integral part of the study, an alternative allocation system will be proposed; and, the implications of adoption of this system will be discussed.

# Methodology

A review of Department of Defense and Air Force regulations with regards to Systems Acquisition and Logistics Support Planning and a literature review on the topic of manpower planning were undertaken. A study of the current Air Force Logistics Command manpower planning and allocation process was conducted through interviews of manpower personnel (Chapter 2).

Detailed analysis of the A-10 weapon systems acquisition and its effect on manpower were undertaken. This analysis included interviews with personnel assigned to the A-10 System Program Office, the Air Force Acquisition Logistics Division, and the Sacramento Air Logistics Center. A detailed analysis of the manpower allocation for the A-10 logistics support is provided (Chapter 3).

A new manpower allocation model was developed and compared to the existing model used by manpower planners (Chapter 4).

A summary of this study and conclusions reached are provided in Chapter 5. Some personal thoughts on the Role of the Industrial Engineer in the Manpower Planning and Allocation Process are provided in the Appendix.

#### Chapter II

# MANPOWER PLANNING AND ALLOCATION CONCEPTS

#### The Private Sector

In discussing manpower planning and allocation concepts, it has become necessary to depart (in most instances) from the study of a public sector entity and consider the private sector at the outset. Although the discussion will consider the private sector, much of the material can be related to the public sector entity of interest.

What is manpower planning? "Broadly stated, manpower planning is usually thought of as comprising those activities that are integral to building an estimate of the size and characteristics of the future work force of an organization" (Wikstrom, 1963). A second definition, provided by Vetter (1964), is: "the process by which a firm insures that it has the right number of people and the right kind of people, at the right places, at the right time doing things for which they are economically most useful." The implication of these meanings will become clearer later in this study.

Armstrong (1977) has stated that one of the aims of manpower planning is to insure that organizations make

the best use of its manpower resources and the organization is able to anticipate the problems arising from potential surpluses or deficits of manpower. Further, an increase in activity level can be catered to by improving the productivity of the current work force in lieu of recruiting more staff. This viewpoint is consistent with Congressional planners in the public sector with regard to wasted manpower; their claim being that a certain level of work can be maintained with less personnel if they were producing to capacity.

The general concept, however, can be summed up as: when new work is received, hire the necessary personnel, train the hirees and place on the job (Northcott, 1956). This viewpoint is consistent with other authors who have written on manpower planning and policies (Meyers, 1977; Weber, et al, 1969; Ginsburg, 1958; Gordon, 1967).

The interesting aspect of the manpower planning role in business is that it appears there is a lack of concern for reallocation of manpower resources. As described above, the planning function concentrates on estimating needs and acquiring manpower to meet those needs. It would be reasonable, however, to expect some attention to be paid to the possible reallocation of manpower resources when new work is received. With the exception

of Armstrong's comment concerning increased productivity with the current work force as a means of accepting new work without additional hiring, reallocation of existing resources does not appear to be a problem in the private sector. This conclusion, while harsh, is based on an extensive review of several periodicals, Personnel (1962-1975), the Personnel Journal (1964-1979), Personnel Administration (1962-1979), and Operations Research (1974-1979). The review failed to disclose any articles or studies dealing with manpower reallocations.

Thus, it is reasonable to state that manpower planning in the private sector is dedicated to the hiring, training, and placement of personnel into the jobs for which they were hired. The connotation implies that the allocation of manpower to specific jobs is a function of the personnel recruitment process. An alternative to this course of action occurs in the public sector.

#### The Public Sector

In the references cited above, manpower planning and policies concentrate on the private sector. In searching for published information concerning manpower planning and allocation processes within the Department of Defense, a search of the Defense Logistics Studies

Information Exchange was conducted. This search revealed that through early 1979, 395 studies relating to manpower have been reported.

A review of these studies failed to disclose any information concerning manpower allocations. What was found was that studies have been conducted that provide for methods to determine manpower requirements at the base unit. For instance, "A new method for determining the maintenance manpower requirements of new aircraft..." (Tetmeyer, 1974). What is lacking is information concerning manpower planning for logistics support. This is not to say, however, that no mechanism exists for the planning of logistics support personnel or that an allocation process does not exist. What is implied is that no real problems in this area have been recognized. However, it is known that the Air Force Logistics Command resorts to "crisis management" when new weapon systems are procured and the logistics support of these systems is transferred to the command. That crisis management involves the immediate reallocation of manpower resources from an existing work load to the new work load. Or, as an alternative to the reallocation process, the manpower planner simply ignores the new work load and assumes that the manpower resources associated with the acquisition of

the system are sufficient to support the system when it is transferred to the command for management. The assignment of personnel by the Air Force Logistics Command during the acquisition process will be explained later.

# The Current Planning Concept

To understand fully the current manpower planning concept and allocation process, it is necessary to describe the United States Air Force weapon system acquisition process since it is this action that generates the new work load for which existing manpower must be allocated.

Each major system acquisition program has its unique features; no two are identical. Differences in time, cost, technology, management, and contracting approach must be recognized. However, despite the differences, the basic acquisition process is common to all programs. All weapon system acquisitions begin with a mission need statement issued by the United States Air Force, based on a mission analysis.

The mission need statement includes the mission purpose, capability, agency components involved, the command responsible for the mission (such as the Strategic Air Command in the case of a long-range retaliatory mission),

time constraints, value or worth of meeting the need, relative priority, and operating constraints. It does not address equipment or other means which might satisfy the need. The mission need statement is submitted to Congress for approval. If approved by Congress, the weapon system acquisition cycle begins. For discussion purposes, it will be assumed that a determination has been made that an aircraft should be required to satisfy the mission need. Therefore, the responsibility for the start of the acquisition cycle is assigned to the Air Force Systems Command, which initiates the system acquisition cycle through the Aeronautical Systems Division.

The system acquisition process is a sequence of specified phases of program activity and decision events directed to the achievement of established program objectives. The first phase of this process is known as the conceptual phase.

During this phase, a concept to provide the required capability is formed, its feasibility is studied, and tested. The military, technical, and economic bases are established by the combined effort of the concerned operational command (the eventual operator of the new system), Air Force Systems Command (the acquisition agency),

and Headquarters United States Air Force (the responsible agency who submitted the need statement).

The preliminary design, maintenance, and operational concepts formulated during this phase become the basis for the initial logistics support estimates and alternatives. These alternatives address the impact of any new design, operational concepts, materials, or components on the current or anticipated logistics support capabilities. The estimates include gross cost estimates for logistics support. The issue of logistics support is addressed later.

The second phase of the system acquisition cycle is the validation phase. This phase consists of those steps necessary to verify preliminary design and engineering, and to solicit and evaluate proposals for engineering development from defense contractors. Program characteristics (performance, cost, and schedule) are validated and refined through extensive study and analysis, hardware development, or prototype testing. The bread board and advanced prototyping efforts are to confirm that the technology is feasible and that the design concept has military utility. Test hardware developed during this phase should demonstrate adequate risk reduction.

The overall objective of the phase is to resolve unknowns and verify that the technical and economic basis for initiating the third phase of the acquisition process, full scale development, exist.

In the full scale development phase, the weapon system, including its support equipment, is engineered, fabricated, and tested. Near-production prototypes are built to verify final design or producibility. System engineering is conducted to support design verification, reviews, test and deployment, identification of detailed requirements for personnel, training, equipment quantity determinations, maintenance, and spares allocations. The intended output of this phase, as a minimum, is a preproduction system that closely approximates the final product.

The fourth phase of the process is the production phase. The system, as well as the training equipment, spares, facilities, and so forth, are produced for operational use. The primary objective of this phase is to produce and deliver to the operating command, an effective, supportable system, efficiently and at the lowest cost. During this phase, operational test and evaluation of the final product are tested by the ultimate user. The

transfer of management responsibility for the system from the Air Force Systems Command to the Air Force Logistics Command occurs during this phase.

The fifth phase of the acquisition cycle is the deployment phase. This phase overlaps the production phase and is affected when the weapon system is turned over to the using command. During this phase, operational units are trained, equipment is distributed, and necessary logistical support is provided.

The span of time that is encompassed during the acquisition cycle varies from system to system. Each system progresses on its own time table. Some cycles can be as short as three years for nonmajor systems to 15 or more years for a major system. As an example, the acquisition cycle for the F-111 aircraft began with the conceptual phase in 1957 and the system remained in production until 1976. The life cycle of a weapon system after production typically extends another 15 to 30 years. Therefore, logistics support for the new system begins during the early acquisition process and extends for many years. Coordination of the development of logistics support requirements with the acquisition process is accomplished through the Integrated Logistics Support function.

Integrated Logistics Support is a composite of all the support considerations necessary to assure the effective and economical support of a system for its life cycle. Logistics Support is an integral part of every aspect of the system acquisition process and system operations. Integrated Logistics Support is characterized by harmony and coherence among all the logistics elements. The principal elements of support are:

a. Maintainability and reliability.

b. The maintenance plan.

c. Support and test equipment.

d. Supply support.

e. Transportation and handling.

f. Technical data.

g. Facilities.

h. Personnel and training.

i. Logistics support resource funds.

j. Logistics support management information.

The output of the Integrated Logistics Support function is recommended support parameters for the above elements. Such parameters are provided as qualitative and quantitative maintainability and reliability inputs to the design process for use in design trade offs, risk analysis, and development of a logistics support capability

responsive to the operational requirements of the weapon system.

The Integrated Logistics Support function is implemented through the Integrated Logistics Support Plan. This document provides a comprehensive and detailed plan for implementing the concepts, techniques and policies necessary to achieve the support objective of assuring the effective economical support of a system for its life cycle. The plan describes the Air Force management objectives, structure, and activities for integration of the logistics elements into program planning, development, test and evaluation, production, and operational processes. The responsibility for developing the plan rests with the program manager.

The program manager is one person, selected by the acquisition agency, who is totally responsible for the system throughout the acquisition process until such time as the management responsibility is transferred to the support agency. To carry out this responsibility, the program manager maintains a System Program Office with eight main divisions (see Figure 1). While all the divisions play an integral part in the development of the plan, the Integrated Logistics Support Division is the primary

# TYPICAL SYSTEM PROGRAM OFFICE





1

20

:

office of responsibility. This office is directed by the Deputy Program Manager for Logistics.

The Air Force Acquisition Logistics Division, an element of the Air Force Logistics Command, has command responsibility for logistics planning and implementation during the conceptual, validation, and full scale development phases of the acquisition cycle. The Air Force Acquisition Logistics Division exercises this responsibility through the logistics manager assigned to the System Program Office. The system management Air Logistics Center is normally designed concurrently with the establishment of the System Program Office to provide a single logistics center management focal point to plan, integrate, track, and control all internal center activities relating to the program.

The Air Logistics Center assignment is a very important element in the planning process. It is the Air Logistics Center which is assigned during the acquisition process that will inherit the new work load required to support the acquired system. Also, the crisis management situation referred to earlier occurs at this organizational level, normally within the Directorate of Material Management. Figure 2 depicts this structure. There are five such Air Logistics Centers within the Air Force

# AIR LOGISTICS CENTER STRUCTURE



# Figure 2

. . .

-----

Logistics Command structure. These centers, in addition to providing system management and logistics support, have the responsibility for depot maintenance, which include all repairs and overhauls of subsystems. The process by which the centers receive the additional work load is known as the "program management responsibility transfer." It will be addressed later.

Within the System Program Office, the logistics manager is responsible for planning, coordinating, and directing the integrated logistics support and logistics management activities as directed by the program manager. The logistics manager accomplishes this task by obtaining functional area support from the appropriate organizations as necessary. A diagram of this process is shown in Figure 3.

The time table for developing the Integrated Logistics Support function, in relation to the acquisition cycle, requires that a general plan for logistics support be available during the conceptual phase. Although this is a macro plan, it is expected that special logistical problems will be noted in the validation phase. Early in the full scale development phase, the plan should include appropriate milestones. The plan should be fully implemented by the start of the production effort. By the time

INFORMATION FLOWS IN

INTEGRATED LOGISTICS SUPPORT PLANNING





. . . . . .

24

.

the deployment phase is reached, a system oriented logistics support should have been obtained and functioning as an element of the total system that meets the capability requirements of the operational mission.

As stated above, the Logistics Support Plan is the vehicle by which the logistics support is implemented. Elements of the Integrated Logistics Support function were also referred to. No one element can be developed without consideration for the others; however, since this study focuses on manpower planning for support requirements, only the element of personnel and training will be examined.

The personnel and training element of the logistics plan is an integral part of the personnel subsystem program. It defines the requirements for operations and maintenance personnel and training devices to support the system. The planner uses the personnel and training element to identify maintenance and training requirements, describe personnel and training aspects of logistics support programs, to pinpoint new critical skills, to assess availability of trained personnel, and to summarize total manpower resources for ten years.

Management of this element requires that a well defined series of schedules be established. The schedule includes derivation of new training programs, assignment of students, transfer of graduates, and manning of new units. The personnel referred to (students and graduates) are the active duty Air Force personnel that will man operational units and who are responsible for maintaining the aircraft. This includes engine mechanics, avionics repairmen, crew chiefs, etc. This element is extremely sensitive to schedule fluctuations established within other elements of the logistics support plan. This sensitivity is the result of the perishable nature of trained personnel (i.e., they will be deployed elsewhere if not employed at the scheduled time).

The development of this element begins during the conceptual phase of the acquisition process when preliminary estimates of maintenance skill requirements and personnel and training concepts are prepared. During the validation phase, preparation of the personnel and training program evaluation criteria is accomplished, and the personnel and training plan are coordinated by the applicable commands.

The determination of personnel availability, a continuous function, is initiated in the full scale

development phase. This requires a review of personnel requirements compared to availability of personnel skills and quantities. Operations and maintenance personnel training is initiated for military personnel during this phase. Towards the end of full scale development, requisite skill levels are verified through system demonstrations; performance standards are corrected and updated, appropriateness of skill level to task, time required to perform tasks, adequacy of support equipment, and adequacy of other support elements.

In the production phase, the availability of trained personnel for operations and maintenance is verified (availability of trained personnel in required quantities and skills for operating units is confirmed). The personnel and training plan is also updated to assure adequacy of personnel through service tests and demonstrations and update plan.

A careful study might lead one to conclude that logistics support personnel have been excluded. The fact is the term "logistics support personnel" does not specifically exist in the literature. The term "maintenance personnel" may be said to include depot maintenance. The use of the term "operations and maintenance personnel"

implies operations personnel are system operators and maintenance personnel are the base level military maintenance.

The personnel who are trained, transferred, and graduated from technical training are the active duty military personnel performing maintenance functions at the base level. They are not the logistics personnel performing maintenance tasks at the Air Logistics Centers. The absence of logistics support is not surprising, since the majority of support personnel required to support a system that is deployed are at the base level of maintenance.

It appears at this point in the analysis, that personnel required to provide support under the Directorate of Materiel Management are not included in the planning.

#### The Current Manpower Allocation Process

In the study of any system or procedure, the most difficult task facing the researcher is one of fully understanding the process under study. In this study, the task has proven to be even more difficult since it became somewhat obvious that a method to forecast manpower requirements for the Air Force Logistics Command resulting from a system acquisition did not exist. This statement is not completely true. What is probably more correct, is to say that a pure model for forecasting manpower requirements does not exist. As previously stated, the planning process inherently assumes that the number of manpower authorizations allocated to the Air Logistics Center, which is receiving the new work load prior to program management responsibility transfer, is sufficient to maintain the system <u>after</u> transfer. This does not mean that the manpower requirements remain static over the life of the system. In fact, as flying hour programs are increased and more information is known about a system, manpower requirements are continually reforecast for the next four to five years.

On the other hand, manpower requirements are established by the Air Logistics Centers in advance of management transfer. Regardless of whether the additional work load is the result of a system acquisition or the transfer of work load from one center to another, the procedures are the same. It is this process which will be analyzed in this section.

In studying manpower requirements, it is necessary to look at the methods used to establish those requirements.
Manpower requirements are supposed to be established according to work load standards. For example: in the item management arena, a requirement is established for a production management specialist based on a standard of one specialist for 120 line items assigned for management. These standards are set as a result of a mutual study effort of the Air Force Logistics Center, the assigned Management Engineering Team (a suborganization of Air Force Logistics Command Headquarters), and the Headquarters Manpower Organization. However, not all positions have standards established. In this case, requirements are zero based. At best, the requirements are established on past experience (where it exists) and subjective reasoning between the parties of concern.

The establishment of manpower requirements for the Acquisition Divisions at the Air Logistics Centers is a case in point. At present, no standards have been established. This is notwithstanding the fact that the divisions have been in operation at the Air Logistics Centers for three years. Presently, there is a concerted effort underway to establish standards for these divisions. The time frame for completing this effort is unknown. The difficulty that arises in developing these standards is the unknown that is generated as a result of systems

acquisition. As previously stated, each system is unique. For example, the performance of the contractor selected by the acquisition agency may generate the need for an estimated standard. If the contractor performs well and does the job the right way the first time, then a standard requiring one person to monitor a portion of the contracted effort can be established. On the other hand, if the contractor does not perform well, it may be decided that additional management manpower is needed. At best, it can be assumed that the contractor will do well and set the standards accordingly.

It should come as no surprise that some standards that are in use are of questionable validity. (E.g., at the Sacramento Air Logistics Center, the Director of Materiel Management has questioned some of the standards used in his directorate). The problem can be shown by looking at the requirements of the divisions and the number of allocations assigned against the requirements. Some divisions are manned at a level of 160 percent while some are manned at 59 percent. Next, we move from manpower standards to the allocation process.

A manpower allocation is the number of personnel that can be employed to fill recognized requirements. The methods used in determining the allocations are somewhat

complex and are best described by an example. When reviewing the example presented, the reader should be aware of three factors: first, is the concept of equal share of allocations among all Air Force Logistics Command units. This concept is intended to insure that each unit will get its fair share of allocations given their stated requirements. Second, the units are functionally oriented and not system oriented. This means that manpower allocations at the units are divided among functional areas such as engineering, system management, item management, distribution, supply, maintenance, etc. This is in contrast to allocations being assigned to specific weapon systems (i.e., F-111 or A-10 aircraft). The functional base is used in spite of the fact that requests for additional allocations are based on new work loads generated by systems. Third, the Air Force Logistics Command has 22 operating organizations that share the allocations. The example will only consider five of these organizations, however, the method described applies across all units.

<u>Example</u>: Within the Air Force Logistics Command structure, there are five Air Logistics Centers. Assume that each center has validated and recognized requirements as follows:

San Antonio Air Logistics Center	4000
Sacramento Air Logistics Center	6000
Warner Robins Air Logistics Center	3500
Oklahoma City Air Logistics Center	4200
Ogden Air Logistics Center	2700
Total	20400

It is assumed that the 20,400 requirements are recognized by Headquarters United States Air Force and the Air Force Logistics Command. Suppose that Headquarters United States Air Force, allocating insufficient manpower, provides only 17,500 manpower allocations to the Air Force Logistics Command to cover the 20,400 requirement. When the 17,500 allocations are received by the command, a leveling factor is calculated by taking the percentage of allocations to requirements. Thus, the leveling factor for this example is:

Leveling Factor =  $\frac{17,500}{20,400}$  = .8578

To maintain the concept of fair share, that leveling factor is applied to all five Air Logistics Center requirements. Thus, the 17,500 allocations will be distributed as follows:

San Antonio Air Logistics Center 4000(.8578) = 3431 Sacramento Air Logistics Center 6000(.8578) = 5147 Warner Robins Air Logistics Center 3500(.8578) = 3002

Oklahoma City Air Logistics Center 4200(.8578) = 3603Ogden Air Logistics Center2700(.8578) = 2317

34

Thus, the center requirements are established and the allocation assigned. Next, we examine what happens when a new work load resulting from a system acquisition is assigned to one of the centers.

Suppose Warner Robins Air Logistics Center Acquisition Division has established a requirement for 120 additional personnel to support an additional system "X" that will be transferred to the center in two years. It will be further assumed that Headquarters Air Force has recognized that the Air Force Logistics Command will require an additional 120 allocations based on the transfer of management responsibility of system "X" from the acquisition agency to the Air Force Logistics Command. Therefore, 120 additional allocations are provided to the command. (It is at this point in the process that allocations are distributed functionally rather than by systems). As a result of the authorization, the established requirements for Warner Robins Air Logistics Center will have increased from 3500 to 3620 while the requirements for the other centers remain the same. However, a new leveling factor is now calculated:

Leveling Factor = 
$$\frac{17,500 + 120}{20,400 + 120} = .8586$$

Applying this new factor to the centers' requirements provides a new set of allocations:

San Antonio Air Logistics Center 4000(.8586) = 3434 Sacramento Air Logistics Center 6000(.8586) = 5152 Warner Robins Air Logistics Center 3620(.8586) = 3108 Oklahoma City Air Logistics Center 4200(.8586) = 3607 Ogden Air Logistics Center 2700(.8586) = 2319

In this example, Warner Robins Air Logistics Center received only 106 additional allocations against the established work load requirement of 120. Each of the other centers received two to five "windfall allocations."

However, even the 106 may not reach the original target organization. Once received at the center level, the total 3108 allocations are distributed as required. This means that the center commander, for example, assigns 12 of the 106 allocations to maintenance due to higher priority work requirements. The remaining 94 allocations are then assigned to the Director of Materiel Management who has the same prerogative as the center commander concerning the use of the additional allocations. He assigns six of the 94 allocations to the System Management Division and the remaining 88 to the Acquisition Division. Figure 4 traces the procedures from the originating agency through the necessary levels of management back to the originating unit.

As shown by the example, the end result of the method employed is that it is conceivable that the recognized requirement for support of a system obtained by a center through transfer of management responsibility could receive zero allocations for the new work load.

#### Program Management Responsibility Transfer

As stated throughout this chapter, the Air Force Logistics Command receives new work loads as a result of the acquisition process, and the mechanism used is the transfer of program management responsibility. The time frame for planning and the allocation of manpower by the Air Force Logistics Command are based on what work load is being transferred and when the transfer will take place.

The key element in the planning and allocation process is the date the management responsibility is transferred from the acquisition agency to the supporting command. It is the established date that resource planning for the supporting command bases its manpower requirements, depot maintenance facilities, and all other aspects of support.



P 1 1

MANPOWER REQUIREMENTS AND

According to all printed regulations, manuals, and guides, the transfer date is supposed to occur early in the production phase of the acquisition cycle. However, historically this has not been the case. The general rule currently used on the F-15 and F-16 weapon system acquisition is that the transfer will occur six months after issuance of the last production contract. The transfer date for the A-10 aircraft was established on the same premise. The date was scheduled for May 1979 based on the issuance of the last production contract that was to be issued in December 1978. However, Congressional action spread the production effort out in such a manner that an additional production contract will be issued. Thus, the transfer date must be reestablished. The importance of establishing the date and not changing the date should not be underestimated. Each responsible command must budget for all required tasks based on the established transfer date. With the budgeting cycle being two years in length, to change the date can mean that the support command may have all the funds necessary to manage the system when, in fact, the acquisition agency will keep the system for an additional time frame.

One of the main factors which is affected is the development of manpower resources to manage the system.

Manpower requirements are established and projected based on the established transfer date. If the work load is not transferred at the stated time, the manpower resources will invariably be used elsewhere. As an example of this problem, consider a case study performed by the United States Army (Neal, 1977). Special equipment had been developed for deployment to Europe and support personnel required to maintain the equipment had been trained and transferred to Europe. The equipment was subsequently delayed by one year; and by the time it arrived at the operating location, the trained operators and maintenance support personnel had been transferred back to the states since their assignments were completed. The Air Force experience would be comparable.

Perhaps the most difficult question that arises with regard to program management responsibility transfer is: "what work load is transferred?" Basically, the work load that is transferred in the context of weapon system management responsibility is a functional work load. The functional work load may consist of all or some of the following:

a. Program documentation and records.

b. Engineering data.

c. Technical orders.

d. Engineering.

e. Configuration management.

f. Material support.

g. Transportation, packaging, and material handling.

h. Procurement.

i. Budgeting and funding.

j. Security.

k. Environmental assessment and statements.

1. Test and evaluation.

m. Safety.

n. Quality assurance.

To define the work load associated with these functional areas in general terms would be very difficult. First, the work load will be dependent on what was accomplished by the acquisition agency and what needs to be accomplished by the supporting agency after transfer. In most cases, the functions can be considered as ongoing throughout the life of the system, but it is the degree of work that cannot be quantified. Second, a highly reliable system will require less work by the support command than a low reliability system. This will affect engineering who must reengineer portions of the system, the budgeting and funding programs to implement the reengineering, and the procurement function which must purchase the replacement

hardware. Third, residual tasks may be retained by the acquisition command. As an example of a residual task, consider the transfer of F-111F aircraft. The total system, with the exception of the aircraft engines, was transferred to the Air Force Logistics Command. The acquisition agency maintained responsibility for the engines for an additional year.

To understand better relationship between functions and work loads, consider the function of technical orders. During the acquisition cycle, technical orders are procured so that system operators will have guidance on how to operate the system, and maintenance personnel will have detailed repair procedures to maintain the system. No technical order remains static even it if started out containing no errors. Various events (such as system changes) will require the update of the technical orders. The responsibility for this update prior to management transfer is assigned to the acquisition agency. After transfer, the responsibility transfers to the support command. The magnitude of the impact is unknown but is dependent on the number of technical orders required to support the system, and whether or not the technical order content was verified by the acquisition agency. For instance, the now nonexistent B-1 bomber

program had developed a requirement for 1200 technical orders compared to approximately 6000 procured to support the F-111 weapon system. It is known that the rate of updates required to maintain the F-111 technical orders averaged 100 per week at the time of transfer.

Prior to the establishment of the Air Force Acquisition Logistics Division (a unit of the Air Force Logistics Command) and the Air Logistics Center Acquisition Divisions, program management responsibility transferred directly to the System and Item Management Divisions of the appropriate Air Logistics Center. The process now in effect is a variable one. For major system acquisition (such as new aircraft), the Air Force Acquisition Division is normally assigned to provide input to and monitor the acquisition process. If a system is in the production phase of acquisition, the acquisition agency may transfer the management responsibility to the Air Force Acquisition Division who, in turn, will transfer the system to the Air Logistics Center Acquisition Division at some later point in time. However, it is conceivable that the Air Force Acquisition Logistics Division could transfer its work load to the Air Logistics Center Acquisition Division or the centers' system/item management divisions prior to the work load transfer from the acquisition agency. If the latter path is followed, then the acquisition agency will

transfer the work load directly to the Air Logistics Center System/Item Management Division. This assumes, however, that the centers' Acquisition Division had previously transferred their work load to System/Item Management Divisions. Figure 5 shows the possible paths the transfer function can take.

The selection of which path is followed is normally based on the work load of the agencies involved and the manpower available to support new systems acquisition. For instance, if the acquisition agency begins an acquisition of a new major weapon system, then the Air Force Acquisition Logistics Division will most likely transfer a system to an Air Logistics Center so that manpower will be available for the new system in acquisition. This process has a domino effect since the action is most likely repeated at the Air Logistics Center level.

#### FLOW PROCESS POSSIBILITIES

1

#### FOR WORK LOAD TRANSFER





---

-

44

\*

#### Chapter III

## ANALYSIS OF MANPOWER PLANNING AND ALLOCATIONS FOR THE A-10 WEAPON SYSTEM ACQUISITION

This chapter examines the weapon system acquisition of the A-10 aircraft and its impact on Air Force Logistics Command manpower. The A-10 acquisition was chosen since the transfer of management responsibility from the acquisition agency to the support agency was scheduled to occur 31 May 1979. In this case study, only the manpower requirement development for logistics support will be considered. The reader is cautioned to keep in mind that although most systems acquisitions are similar in nature, the uniqueness of each system sets apart various management techniques employed by the program managers. Therefore, the finding in this case study may not be completely generalized to all weapon systems acquisitions.

The primary areas to be considered in this case study are: (1) the A-10 acquisition cycle, (2) the Air Force Logistics Command manpower planning and allocations during the acquisition cycle, (3) the program management responsibility transfer manpower requirements, and (4) the A-10 integrated logistics support plan.

Since certain data were not available in existing records, personal interviews had to be conducted. The data obtained are the results of personal recall of the interviewees. These data will be noted by an asterisk (\*). Other data reported were obtained from the files of the A-10 System Program Office, the Air Force Logistics Command Manpower and Organization Directorate, and Sacramento Air Logistics Center.

#### The A-10 Acquisition Cycle

In the early to mid 1960s\*, the United States Air Force developed a mission need for a specialized close air support aircraft to replace the aging A-10 aircraft as the primary weapon system for close air support mission (close air support is defined as aircraft support for ground troops in a combat zone). In approximately 1968\*, requests for proposals were forwarded to defense contractors for the development of an aircraft to meet the close air support role. Six contractual proposals received in August 1970 resulted in selection of Northrop Aircraft Company and Fairchild Republic to develop prototype aircraft for competitive flyoff. On 1 March 1973, as a result of the flyoff, a contract was awarded to Fairchild Republic Company to produce ten aircraft. In

the acquisition process, this action initiated the full scale development phase.

During the fiscal year 1975 (July 1974 through June 1975) budget cycle, the Congress deleted funds for four of the ten aircraft. In addition, the Senate Armed Services Committee recommended that a flyoff between the A-10 and the A-7D aircraft (already in the Air Force inventory) be conducted to assess the capability of both aircraft to perform the close air support mission. These actions resulted in a stop work order to Fairchild Republic Company, a realignment of the production/delivery schedules for the first six aircraft, and renegotiations of the existing contract. The flyoff was conducted and the A-10 was declared the winner over the A-7D by both the Air Force and the Department of Defense Weapon System Evaluation Groups. On 9 July 1974, the Defense Systems Acquisition Review Council met to review the A-10 program. The council is an office of the Secretary of Defense advisory body consisting of the Director of Defense Research and Engineering, and Assistant Secretaries of Defense for Program Analysis and Evaluation, Installations and Logistics, Comptroller, and, for their particular programs, Intelligences and Communications. The council noted that excellent progress had been made on the prototype and development programs of

the aircraft. As a result of that meeting, the Deputy Secretary of Defense approved the initial production of 52 aircraft. Subsequent Congressional action on the fiscal year 1975 Department of Defense Appropriations Bill reduced the A-10 aircraft procurement to 30 aircraft. Full funding was authorized in July 1975 for 30 aircraft. Thus, the production cycle began in fiscal year 1975. An additional Defense System Acquisition Review Council was completed in February 1976. As a result of the council's review, approval was granted by the Secretary of Defense for production go ahead for 733 A-10 aircraft. The production was scheduled to be completed in January 1983. The deployment phase of the acquisition cycle began between April and June 1976 with the delivery of the first A-10 aircraft to an operational unit.

In analyzing the A-10 acquisition cycle, note that several Congressional actions were mentioned. These instances have been cited to show that a program schedule is subjected to non-Department of Defense influences. These influences may or may not impact the integrated logistics support planning function.

Air Force Logistics Command Manpower Planning and Allocation During Acquisition

First, the reader is reminded that this discussion of the Air Force Logistics Command manpower during the A-10 acquisition manpower planning and allocations does not address depot maintenance personnel. Second, remember that all Air Logistics Centers are impacted by the acquisition of a system. For instance, with the A-10, the system management function for the airframe is assigned to the Sacramento Air Logistics Center; the aircraft engines to San Antonio Air Logistics Center; and the gun to Warner Robins Air Logistics Center. However, in most cases, it is the system Air Logistics Center which receives the greatest work load as a result of a new system acquisition program.

In March 1970, the Air Force received authorization for the acquisition of the A-10. As a result of this action, a System Program Office (the responsible acquisition agency) was formed. The Air Force Logistics Command (the support agency), the Tactical Air Command (the designed system operator), and the Air Training Command (operations and training responsible agency) assigned personnel to the System Program Office. The Program Office organization for the A-10 is essentially the same as that shown in Figure 1. Five to six\* Air Force Logistics Command personnel were involved at this point in time. However, the equivalent of five\* logistics

command personnel was involved in the acquisition process between 1966-1970\*. During the period 1970-1974\*, the Air Force Logistics Command manpower allocations were in the range of 10-20\*. This included manpower allocations to the Program Office and the Sacramento Air Logistics It should be noted, there was no manpower planning Center. for the Directorate of Materiel Management for the A-10 support during the period 1966-1974. This was not an intentional lack of planning but resulted from the way in which the procedure was conducted. During the early portions of the acquisition cycle, schedules are not finalized and those that are, are subject to changes. Therefore, it was impractical if not impossible to project requirements during these early phases. The balance of this section will address only the Sacramento Air Logistics Center manpower planning and allocations for the A-10 aircraft.

In November 1975\*, the center developed the first A-10 manpower support requirement package. This planning package was submitted to the Air Force Logistics Command Manpower and Organization Directorate in January 1976. The package was developed and submitted in anticipation of the approval for the A-10 aircraft. At this time, the center was authorized 46 personnel to support the acquisition. The package submitted showed a requirement for a

manpower buildup through the fourth quarter of fiscal year 1976 (May-June 1977). The projected requirements and approved allocations presented in the package are shown in Table 1.

MANPOWER RE	QUIREMENTS AND	ALLOCATIONS
	NOVEMBER 1975	•
TIME FRAME	PROJECTED REQUIREMENTS	AUTHORIZED ALLOCATIONS
October-December 1975	53	46
January-March 1975	68	46
April-June 1975	84	46
April-June 1976	86	46

#### Table 1

At the beginning of fiscal year 1975, a change in planning procedures was initiated by the Air Force. The new procedures required that manpower requirements be submitted 24 months in advance of the time for which the requirements are needed. For example, if an organization develops a requirement for additional manpower in fiscal year 1981 (October 1980-September 1981), the requirement must be submitted prior to October 1978. (NOTE: The fiscal year periods were changed by Congress in 1976 from July through June to October through September effective 1 October 1976). As a result of the planning procedure changes, the manpower package submitted in November 1975 was disapproved since the requirements could not be entered into the planning cycle for which the requirements were needed. Ultimately, the package was submitted two years late.

However, during the period November 1974\* to June 1976\*, the requirements were adjusted to 61 and the allocations were set at 61.

The second manpower package for the Sacramento Air Logistics Center's Acquisition Division in support of the A-10 aircraft was submitted to the Headquarters Air Force Logistics Command in December 1976. Recall that the requirements and allocations prior to December 1976 in support of the A-10 aircraft were 61. Table 2 shows the additional manpower requirement projected and reported in this package.

Since requirements are to be submitted two years in advance, it can be seen that the package was not submitted in sufficient time to cover the requirements through December 1978. However, the package was not rejected in total. The Air Force Logistics Command Directorate of

Manpower and Organization did provide an additional 57 allocations to the center for support of the A-10 aircraft. When those allocations were received by the center, only 12 were provided to the Acquisition Division and the other 45 were allocated to other programs considered to be of a higher priority. These programs could not be identified. Subsequently, allocations for the Acquisition Division in support of the A-10 have grown to and fluctuated around 88 to the present time.

SACRAMENTO AIR LOGI	STICS CENTER ACQUIS	ITION DIVISION				
A-10 MANPOWER REQUIREMENTS						
DECEMBER 1976						
TIME FRAME	ADDITIONAL PROJECTED REQUIREMENTS	TOTAL REQUIREMENTS				
October-December 1977	39	100				
January-March 1978	40	101				
May-June 1978	57	118				
July-September 1978	57	118				
July-September 1979	66	127				
July-September 1980	68	129				
July-September 1981	69	130				

Table 2

In March 1978, the third manpower planning package was submitted to the Headquarters Air Force Logistics Command. The package contained some discrepancies and was returned to the center to be reworked. The final package with corrections was then submitted 17 October 1978. The additional requirements plus the total requirements described in this package are shown in Table 3.

SACRAMENTO	AIR LOO	SISTICS	CENTER ACQUISITIO	N DIVISION			
A-10 MANPOWER REQUIREMENTS AND ALLOCATIONS							
17 OCTOBER 1978							
TIME FRAME	ADI REQU	DITIONAL JIREMENT	CURRENT S ALLOCATIONS	TOTAL REQUI REMENTS			
By September	1979	90	88	178			
By September	1980	86	92	178			
By September	1981	86	92	178			
By September	1982	86	92	178			
By September	1983	86	92	178			
1							

#### Table 3

Although the package was very extensive and detailed, it was rejected based on a headquarters assumption that the requirements were inflated. Therefore, the center's requirements for support of the A-10 aircraft were

recognized at 130 and leveled to 104 allocations using the leveling procedure explained in Chapter 2. Although the A-10 program at the center has 104 allocations, the Directorate of Materiel Management has authorized only 85 personnel to the Acquisition Division to support the aircraft. The other 19 allocations are being used for other programs deemed to be of higher priority. The identification of these other programs cannot be identified since the allocation process at the center level is functionally oriented and not system oriented.

The major result of the deficient authorization is that the third package has been submitted by Sacramento Air Logistics Center requesting additional manpower authorizations necessary to assume management responsibility of the A-10 system at the time of transfer. This request was based on an assumed transfer date of 30 May 1979. It should be noted, however, that the transfer date is presently under consideration for change. The new date has not been established but it is recommended that the transfer should occur during the period October 1979-January 1981.

#### The Program Management Responsibility Transfer Requirements

The changing of the transfer date, while affecting the manpower allocations time table, does not significantly

reduce the new work load that will be transferred to the Sacramento Air Logistics Center. Referring to Table 3, the additional requirements include 86; 40 are for anticipated current work load increases and 46 are for support of the new work load. Headquarters Air Force Logistics Command has questioned the nature of this increased work load. The new work load was identified in the 17 October 1978 manpower package. A partial listing of the functional responsibilities that the center will assume on the transfer date is shown in Figure 6.

The failure to recognize this new work load will result in the crisis management situation alluded to in Chapter 2. The basis for the rejections of these requirements is that the work load is not quantifiable and is based solely on subjective reasoning. This leads to the question of integrated logistics support planning. Was the planning adequate to preclude this lack of recognition? To evaluate this question, a discussion of the A-10 integrated logistics support plan follows.

#### The A-10 Integrated Logistics Support Plan

As of May 1979, there was no integrated logistics support plan for the A-10 weapon system. In the 1975-1976\* time frame, the program management plan for the A-10 was

# FUNCTIONAL RESPONSIBILITIES ASSUMED BY SACRAMENTO AIR LOGISTICS CENTER IN SUPPORT OF THE A-10 AIRCRAFT

System Engineering

Training and Training Equipment Management

Engineering Changes

Aircraft Acceptance

Waiver and Deviations

Quality Assurance

Specification Management

Spares Contracting

Accident and Incidents

System Safety

Modification Management

Site Activation

Technical Orders Management

Figure 6

terminated by the program director. This was done in conjunction with the development of the A-10 management information system which replaced the management plan. Included in the management information system was some logistics support information but not in the detail of a logistics support plan, since the planning had been completed and the system was in production. The last updated plan for the A-10 was issued in September 1975. It was this document that was reviewed for this case study. Once again, only the element of personnel and training will be examined.

The personnel and training element of the A-10 support plan was devoted to the training of the logistics personnel. (NOTE: This is contrary to the discussion of the personnel and training element in Chapter 2 which seemingly omitted consideration of logistics support personnel). Pertinent paragraphs of the personnel and training element of the A-10 support plan are quoted and discussed as deemed necessary.

"...Air Force Logistics Command personnel will require training in five specific areas. These are: pilot training, engineering training, depot overhaul training, intermediate level training, and management/ engineering training." The training for the pilots, engineering, and depot overhaul is concerned with the

maintenance aspect of the logistics support. The training for engineering, intermediate level, and management/engineering is concerned with the support role of logistics personnel. For instance, intermediate level training, although an operational function, allows for the Air Logistics Center equipment specialist and technicians to become familiar with the equipment they will manage at after program management transfer.

"A manpower validation model will be used in place of the qualitative and quantitative personnel requirements information (QQPRI). This model will provide information similar to that normally contained in the QOPRI. (NOTE: The qualitative and quantitative personnel requirements information is the methodology used to relate maintenance task to required skills needed to perform that task. It uses information from other studies such as reliability, maintainability, etc. Based on this information, predictions of the number of personnel in each skill required to maintain the system is made. However, this is limited to field level personnel). The manpower validation model used in lieu of the qualitative and quantitative personnel requirements information for the A-10 was a model developed by the Air Force Human Resources Laboratory. The report (Tetmeyer, 1974) describing this model states, "The

methodology and models described in this volume have been successfully applied on the A-10 program...." The model does not include logistics support personnel but does indicate that "work is underway in conjunction with Air Force Logistics Command to incorporate this methodology into a system for total logistics trade offs and life cycle costing."

#### Summary and Conclusions

There are several conclusions that can be drawn from this case study, however, only those consluions that have a direct impact on the manpower planning and allocation process will be addressed.

The Sacramento Air Logistics Center, in November 1975, December 1976, and October 1978, submitted a manpower package requesting additional personnel to support the A-10 weapon system to Headquarters Air Force Logistics Command. The three manpower packages were considered "late" since manpower requirements for the first two years from the date of the package were included and a requirement existed for a manpower package to be submitted 24 months in advance of the time the manpower requirement is needed. It can be concluded that the manpower planners at the Sacramento Air Logistics Center are not aware of or

disregard the planning cycle time frame. It is possible for the center to acquire a work load which will not allow for the 24 month advance planning; but in this case, sufficient time was available.

The third manpower package, submitted by Sacramento Air Logistics Center, was rejected by the headquarters based on an assumption that the requirements were inflated. Recalling from Chapter 2 that manpower requirements are established and approved by the operating units' Management Engineering Teams, the planning for manpower should be considered as a wasted effort.

Manpower requirements submitted by Sacramento Air Logistics Center were for support of the A-10 weapon system. Although the current recognized requirement is 130, the requirements have been leveled to 104 through the leveling technique explained in Chapter 2. Of the 104 allocations provided to the center, 85 were allocated to the requesting division and 19 allocations to other divisions deemed to have a higher priority work load. Therefore, it is concluded that other operating units have reaped a windfall of allocations based on the requirements of one division at Sacramento Air Logistics Center. It can be further concluded that the basis for manpower

allocations is inconsistent with the basis for determining manpower requirements.

New work loads that result from system acquisition are not quantifiable and are based solely on subjective reasoning; therefore, this work load is not recognized by headquarters. The fact that the incoming work load cannot at some degree be measured objectively indicates a lack of coordination between the System Program Office, the Acquisition Logistics Division, the Sacramento Air Logistics Center, and the Headquarters Air Force Logistics Command.

While the A-10 Integrated Logistics Support Plan considered training requirements for logistics support personnel, manpower requirements were not addressed. Throughout the above discussion on manpower planning, it is shown that the manpower planning for support of the A-10 was done in isolation to the System Program Office which has the responsibility for this planning. Thus, it is concluded that manpower requirements for the Directorate of Materiel Management at Sacramento Air Logistics Center in support of the A-10 weapon system cannot have a sound basis in relation to the work load the center will receive.

### Chapter IV MANPOWER ALLOCATION MODEL

Manpower planning throughout the Air Force Logistics Command complex, with regards to weapon systems acquisition, is basically oriented to the manpower requirements necessary for the command to manage the system after acquisition and transfer of program management responsibility. However, the allocation of manpower, especially at the Air Logistics Centers, is functionally oriented. As was found in the A-10 aircraft case study, the additional requirements needed to support the system after transfer were not recognized. This means that the command did not seek additional allocations from Headquarters Air Force. The excuse offered by the command is essentially that a method is not available to relate manpower requirements to systems. Further, there is no control mechanism to advise Headquarters Air Force when a work load has decreased.

The purpose of this chapter is to explore a method that can relate manpower requirements to systems and manpower allocations to those requirements.

#### Model Development

One factor that can be used to relate a major aircraft system to other systems is the number of flying hours assigned to each system by Headquarters Air Force. It is also known that aircraft support requirements are a function of flying hours. The flying hour programs are published at frequent intervals and are subject to change. As a result, flying hour programs can be said to be variable. This variability can be caused by a decrease in available aviation fuel, or flying hour programs can vary based on the phasing in or out of new and older systems.

Flying hour programs are, at best, estimates. Factors such as fuel availability, international crisis, aircraft maintainability, and aircraft reliability will cause these estimates to vary. For example, the United States Government may offer airlift support to a foreign government to fly in medical, food, and other supplies to a country struck by an earthquake. Since earthquakes are not forecasted, planning for flying hour programs will not include these types of emergencies. On the other hand, an oil boycott by the world oil ministers can cause a cut in flying hour programs due to a shortage of aviation fuel. Thus, there is uncertainty in the number of flying hours a system may accumulate during a period of time.

Since there is a set of three possible flying hour estimates (minimum, most probable and a maximum), the problem of reducing these estimates to a single average estimate (u) can be solved by using the Beta distribution. This is similar to the PERT methodology which takes uncertainty into account by assuming that time estimates were probability distributions and the schedules for all of the activities reflected the uncertainty of the activity times (Buffa and Taubert, 1972).

Thus, to incorporate the variability of flying hours over time for a given system, it will be assumed that the expected flying hours for any given system can be represented by the Beta distribution of the form;

$$u = \frac{a + 4m + b}{6}$$

where: m is the most probable flying hours

a is the minimum number of flying hours

b is the maximum number of flying hours

With this equation, the expected flying hours for each system at each Air Logistics Center can be calculated. Since flying hours are a common attribute of all aircraft systems, this attribute will be used as a basis for developing manpower requirements and allocations.
The next step in the process requires that the total expected flying hours for each center and the total flying hours for all programs be determined. With these results, a computed weighting factor can be obtained by taking the ratio of the sum for each center to the total for all centers. Consider the following example:

<u>Example</u>: Assume there are three Air Logistics Centers and each center manages two aircraft systems. Denote the centers by subscripts A, B, and C, with numerical subscripts 1 and 2 to denote the aircraft systems. Flying hours will be assumed. Then:

$$u_{A1} = \frac{900 + 4(1000) + 1200}{6} = 1016 \text{ hours}$$

$$u_{A2} = \frac{1000 + 4(1100) + 1250}{6} = 1108 \text{ hours}$$

$$u_{B1} = \frac{800 + 4(950) + 1050}{6} = 941 \text{ hours}$$

$$u_{B2} = \frac{1200 + 4(1400) + 1500}{6} = 1383 \text{ hours}$$

$$u_{C1} = \frac{1100 + 4(1250) + 1350}{6} = 1241 \text{ hours}$$

$$u_{C2} = \frac{700 + 4(850) + 900}{6} = 833 \text{ hours}$$

The total expected hours for all systems at all centers are 6522. Weighting factors for each center, then, are the ratio of total center hours to all system hours:

$$C_{A} = \frac{1016 + 1108}{6522} = .326$$

$$C_{B} = \frac{941 + 1383}{6522} = .356$$

$$C_{C} = \frac{1241 + 833}{6522} = .318$$

The calculated weighting factors will be used later.

The next step in this procedure requires the determination of a manpower factor for each program at the centers. This factor relates the number of personnel required to support a system to the number of flying hours for the system. Since some systems are more complex than others, the factor will vary. A method for determining the factors will be discussed in the next chapter. For this model, the factors, expressed in support persons for flying hours, will be assumed to be:

$$A_1 = .8$$
  
 $A_2 = 1.0$   
 $B_1 = 1.1$   
 $B_2 = .95$   
 $C_1 = .85$   
 $C_2 = .90$ 

Applying these factors to the expected number of flying hours for each program yields the manpower requirements required to support the individual systems. Therefore, the estimated manpower requirements (MR) will be:

 $MR_{A1} = .8 \times 1016 = 813$   $MR_{A2} = 1.0 \times 1108 = 1108$   $MR_{B1} = 1.1 \times 941 = 1035$   $MR_{B2} = .95 \times 1383 = 1314$   $MR_{C1} = .85 \times 1241 = 1055$   $MR_{C2} = .90 \times 833 = 750$ 

TOTAL SUPPORT

It is assumed that included in the above factors was an allowance for indirect support. This implies that a minimum number of personnel will be required to directly support the system in order to maintain a wartime capability. Therefore, it will be assumed that as a minimum, each center will need 50 percent of the estimated requirements. Thus, the minimum manpower for each center is:

= 6075

A = 1921 X .5 = 960
B = 2349 X .5 = 1174
C = 1805 X .5 = 902
Total Minimum
Requirements 3036

With the manpower allocation to the various commands being controlled by Headquarters Air Force, the expected number of allocations to the Headquarters Air Force Logistics Command will equal 80 percent of the stated requirements. Thus, the total allocation for the centers will be 4860. The difference between total allocation and minimum requirement (4860 - 3036 = 1824) is the unassigned allocations which are available to be distributed on the basis of the objective function.

With the above generated data, an assignment algorithm can be constructed. The objective equation used in the algorithm makes use of the weighting factors calculated above. The use of these factors will insure that the logistics center with the greatest proportional work load will receive the greatest proportion of manpower allocations. The model is of the form of a linear programming algorithm such that:

Maximize  $Z = C_A X_A + C_B X_B + C_C X_C$ 

Subject to:  $X_A + X_B + X_C \leq Manpower Available-Minimum Requirements.$ 

 $X_{A} \leq$  Center Requirements-Center Minimum.

 $X_{R} \leq$  Center Requirements-Center Minimum.

 $X_{C} \leq Center Requirements-Center Minimum.$ 

 $X_{A}, X_{B}, X_{C} \geq 0$ 

Where:  $X_A, X_B, X_C$  represent the additional manpower allocations to the respective centers.

Therefore, algorithm for this model will be:

Maximize  $Z = .326X_{A} + .356X_{B} + .318X_{C}$ 

Subject to:  $X_A + X_B + X_C \le 1824$ 

 $x_{A} \leq 961$  $x_{B} \leq 1175$  $x_{C} \leq 903$  $x_{A}, x_{B}, x_{C} \geq 0$ 

To solve the algorithm requires the constraints be converted to the standard form such that:

Maximize  $z = .326X_A = .356X_B + .318X_C$ Subject to:  $X_A + X_B + X_C + X_D = 1824$   $X_A + X_E = 961$   $X_B + X_F = 1175$   $X_C + X_G = 903$  $X_{A}, X_B, X_C, X_D, X_E, X_F, X_G \ge 0$ 

Inspection of the example shows the solution to be by the following rule: Select the center with the highest weighting factor and allocate as many manpower units as possible or needed, whichever is smaller. Move to the next highest weighting factor and repeat the allocation process. Continue the process until all centers have been considered or the number of manpower allocations available is exhausted, whichever comes first.

$$x_{A} = 649$$
  $x_{D} = 0$   $x_{G} = 0$   
 $x_{B} = 1175$   $x_{E} = 0$   
 $x_{C} = 0$   $x_{F} = 0$ 

Then using this allocation process, the manpower allocations to the three centers will be:

Center A - 1609 Center B - 2349 Center C - 902

In order to compare these results with the current method, it will be assumed that the stated requirements for each center are the same as those calculated above. Then applying the leveling technique the level factor will be:

 $LF = \frac{\text{Allocations Authorized}}{\text{Total Support Requirements}} = \frac{4860}{6075} = .80$ 

Applying these factors to the requirements, each center would then receive the following allocations:

Center A - 1536 Center B - 1879 Center C - 1444

These results indicate that Centers A and B, even though they have the largest work load, will receive fewer allocations to perform their task.

Model Advantages/Disadvantages

The primary advantage of the proposed allocation model is that manpower requirements and allocations can be related directly to weapon systems. Thus, as flying hours increase, the Air Force Logistics Command will have a sound basis upon which to request additional manpower allocations from the Headquarters Air Force. The second advantage comes into play during the phasing out of the weapon system. This technique can be applied to allocate manpower during both phasing in and phasing out of work loads. During phasing out, the reduction in estimated work loads will affect the objective equation and the requirements; however, the end results will be the most allocations will be assigned where the need is the greatest.

The major disadvantage of this method is that it may be impossible to establish factors which relate manpower requirements for certain jobs within the Air Force Logistics Command complex to flying hours. For instance, the requirement for the staffing of the command headquarters may not be related to flying hour programs. Therefore, it will become necessary to develop supplementary allocation procedures to cover that type of position.

#### Conclusions

The model described in this chapter could be used for determining manpower requirements and allocations at the

Air Logistics Centers and other operating units where requirements can be related directly to flying hour programs. By using this method, the command can justify to the Headquarters Air Force the need for additional allocations required to support a new system when program management responsibility transfer occurs. More important, however, is the fact that the allocations which are projected using the model are rationally related to the work load imposed by the weapon systems under consideration.

## Chapter V SUMMARY AND CONCLUSIONS

#### General Discussion

Manpower planning plays an important role in both the private and public sector. For private sector manpower allocations, the general practice employed is to hire the manpower necessary to produce the product, given projected income and expense related to it. The number of persons that can be employed within the public sector is normally limited by broader budget constraints at the state and local levels and by Congressional constraints with regard to Department of Defense organizations. Here, revenues flow from taxes rather than return from the product or service being delivered.

With new weapon systems entering the Air Force inventory at a faster pace than old systems are leaving, the support personnel often must be generated from existing manpower resources. However, it may be possible for the support agency (in this case, the Air Force Logistics Command) to gain additional manpower allocations if the requirements for the manpower can be related to particular weapon systems. The current practice employed by the

command is to allocate manpower resources to functional areas such as engineering, maintenance, system management, etc., where as original estimates of manpower requirements are based on projections of system operating levels, which do not include logistics manpower.

This analysis of manpower planning for new work loads resulting from the weapon system acquisition found that the actual process is somewhat vague. Although provisions for such a planning function exist, there appears to be a void when it comes to nonoperational logistics support personnel. The concept of integrated logistics support and the support plan developed from this concept theoretically provide for personnel and training. However, operational and maintenance personnel appear to receive the emphasis of this planning function. Logistics support personnel are apparently overlocked. The A-10 aircraft acquisition was analyzed and reported as the case study in this thesis. That study revealed that manpower planning for support personnel at the Sacramento Air Logistics Center was performed as a separate function in the acquisition process. There was no evidence found that the manpower planning process was related to the system acquisition activity.

The allocation system used by the Air Force Logistics Command is intended to be equitable since it is based on a principle of fair share of allocations to all operating units. However, the analysis conducted herein shows that, at the unit operating level, the allocations are based on functional areas where requirements are based on system needs. Using a system oriented planning and allocation process for logistics support, similar to the one developed in this study, will allow for manpower planning and allocations to be based on a total system program. Using flying hour programs as the common ground applicable to all systems, then verifiable requirements can be maintained.

## Limitations and Suggestions for Further Research

The modeling technique presented in Chapter 4 should not be considered as the solution to the total Air Force Logistics Command manpower planning and allocation process. The model has not been tested but simply developed and was based on a single case study. Additional work will be required to fully develop the system complexity factors used to determine manpower requirements. The minimum manpower allocations (50% of requirements) used in the model were subjective and require that a study be conducted to determine the minimum allocations for each operating location. Thus, the underlying concept presented should

be subjected to further study. With the concept as a starting point, further studies can be initiated to validate the concept of a system oriented manpower planning and allocation process.

Studies in the area of work standards should be considered. Presently all operating units establish their own standards. It is believed that some of the standards developed at one operating unit are applicable at others. Thus, the standards study should be geared to a consolidated effort so that standards across all operating units can be standardized.

#### Conclusions

The integrated manpower planning process, as it is now conducted during weapon system acquisition, systematically ignores manpower requirements for Air Force Logistics Command support personnel.

When support manpower requirements are established, the basis for their determination is <u>system operating</u> considerations. When allocations are finally made, the basis for the Air Force Logistics Command is <u>functional</u>. The inconsistency in planning bases effectively short changes the logistics support function. A program of allocation, which relates all support manpower to system parameters, is severely needed.

Manpower allocations, as they are currently implemented in the Air Force Logistics Command manpower process, systematically short changes the Air Logistics Center receiving the additional work load which accompanies a new weapon system acquisition and distributes the shortfall to other Logistics Centers.

An allocation algorithm, which fixes minimum manpower quotas and which distributes the remainder of the allocations on a weighted basis, will produce "fairer" allocations consistent with established work loads.

## Appendix

# SOME PERSONAL THOUGHTS ON THE ROLE OF THE INDUSTRIAL ENGINEER IN THE MANPOWER PLANNING AND ALLOCATION PROCESS

Historically, manpower planning in the private sector has been a function of the personnel staffs within a business or corporation. In the public sector, the personnel department also provides the necessary inputs to management concerning manpower planning. However, what should be considered as a vital input to any planning function is the role that the industrial engineer can play to enhance this function. The purpose of this Appendix is to attempt to identify what inputs the industrial engineer can make in the planning and allocation processes in both the private and public sector.

## The Private Sector

Referring to Armstrong's comments stated in Chapter 2 of this study, "using increased productivity with the current work force as a means of accepting new work without additional hiring" lead one to believe that such a productivity study can be performed by the industrial engineer. Work standards can be developed by the industrial engineer for all phases of the business operation and a determination

can be made if a change in standard would result in excessive manpower that could be used for additional new work. Further, the industrial engineer can perform plant layout studies so that an optimal placement of new equipment will help determine the optimal number of personnel required to operate the equipment.

The industrial engineer, using predetermined time systems and other techniques can evaluate the new work loads to determine manpower requirements. Other techniques (such as linear programming, assignment algorithms, and the transportation algorithm used by the industrial engineer) can provide vital information to management as to the optimal manpower allocations for work loads.

These types of information can be used by the personnel staffs and other management functions in planning for and the allocations of manpower.

#### The Public Sector

Increased productivity of the current work force within the public sector is a major concern of government agencies at the local, state, and federal levels. This is due to, as previously stated, a continued decrease in budgets necessary to acquire personnel to maintain an ever increasing work load. In this sector, the role of the

industrial engineer will be discussed in relation to new work loads generated as a result of weapon systems acquisitions within the United States Air Force.

The industrial engineer's role in weapon system development cannot be overlooked. The industrial engineer could provide valuable inputs to the system design process early in the acquisition process. Most of these inputs would be human factor engineering information, but these inputs will have an effect on manpower planning and allocations at a later time. For instance, the industrial engineer using his/her human factor's knowledge, can influence the design of systems or subsystems that will insure that a man-machine interface is considered in that design. A subsystem may be designed without the benefit of the human factors and the end result could be that two operators would be required to operate the system. On the other hand, if human factors had been applied, one operator may be required.

Therefore, the industrial engineer's inputs to the design of any system will be an influencing factor in manpower planning and allocations, even though in most cases this influence is not or cannot be recognized. However, this is just the first identifiable role the

industrial engineer has in the planning and allocation process within Air Force.

Two Air Force Logistics Command organizations (the Directorate of Manpower and Organization and Management Engineering Teams - a sub unit of this directorate) were alluded to in Chapter 2. It is this directorate that allocates manpower spaces to all command operating units. The staff of this organization consists of several industrial engineers whose responsibilities include determining current manpower requirements and future requirements. The organization reviews all manpower requirements and planning documents submitted by the command operating units and either approves or disapproves the requirements.

The Management Engineering Teams are local detachments assigned to most of the operating units. The Management Engineering Teams are manned mostly by industrial engineers and provide services to the local commanders in terms of manpower planning and validation of requirements. An additional function of the Management Engineering Teams is to establish new and validate existing manpower standards. When it is determined that a new work load is being assigned to an operating unit, it is the Management Engineering Teams' personnel who develop the standards for the new work load and determine what manpower requirements will be required to meet these standards. Predetermined time systems and other work measurement techniques are used in developing the standards.

In Chapter 4 of this study, weapon system complexity factors were used in the development of the model pre-There are perhaps several ways that the factors sented. could be developed. However, the key discipline that would have the necessary training and techniques to develop these factors is the industrial engineer discipline. Work measurement studies and predetermined time system techniques would be employed by the industrial engineer to determine how long it takes and the complexity of repair to systems and their associated subsystems. This data, along with system reliability and maintainability information taken from existing maintenance reports, will enable the industrial engineer to develop the necessary factors to use in determining manpower requirements.

It should be emphasized that not all job positions within the Air Force Logistics Command have had standards applied. It is the lack of these standards that hamper the current manpower planning process. It is difficult to justify manpower requirements when the standards do not exist. The basic problem is that the growth of manpower

requirements during wartime conditions followed by the continuous development of new and more complex systems continues at a pace far greater than the capabilities of command's industrial engineers to develop standards. A concerted effort is being made to develop the needed standards, but the present engineering staff is inadequate.

## BIBLIOGRAPHY

#### Books

- 1. Armstrong, Michael. <u>A Handbook of Personnel</u> <u>Management Practice</u>, London: The Anchor Press, 1977.
- Buffa, Elwood S. and Taubert, William H. Production - <u>Inventory Systems</u>: Planning and Control, Homewood IL: Richard D. Irwin, 1972.
- 3. Ginzburg, Eli. <u>Human Resources: The Wealth of a</u> Nation, New York: Simon and Schuster, 1958.
- Gordon, Robert Aaron. <u>Toward A Manpower Policy</u>, New York: Whiley, 1967.
- 5. Meyers, Charles A. and Pigors, Paul. Personnel Administration - A Point of View and A Method, New York: McGraw-Hill, 1977.
- Northcott, C. H. <u>Personnel Management Principles</u> and Practice, New York: Philosophical Library, 1956.

## Articles and Periodicals

- 7. Vetter, Eric W., The Nature of Long-Range Manpower Planning. <u>Management of Personnel Quarterly</u>, Summer 1964, p21.
- 8. Wikstrom, Walter S. Planning for Manpower Planning. Business Management Record, August 1963, p30.

#### United States Government Documents

- 9. Air Force Acquisition Logistics Division Regulation 800-2. Acquisition Management. Wright-Patterson Air Force Base: Air Force Acquisition Logistics Division, May 5, 1978.
- 10. Air Force Logistics Command Regulation 23-17. Air Force Acquisition Logistics Division. Wright-Patterson Air Force Base: Air Force Logistics Command, September 8, 1977.

- 11. Air Force Logistics Command Regulation 23-43. ALC Directorate of Materiel Management. Wright-Patterson Air Force Base: Air Force Logistics Command, March 16, 1977.
- 12. Air Force Logistics Command Regulation 400-1. Logistics Management Policy. Wright-Patterson Air Force Base: Air Force Logistics Command, February 10, 1978.
- 13. Air Force Logistics Command Regulation 800-9. <u>Management of DPML/ILSOs</u>. Wright-Patterson Air Force Base: Air Force Logistics Command, December 8, 1978.
- 14. Air Force Regulation 23-2. Air Force Logistics <u>Command</u>. Washington, D.C.: Department of the Air Force, February 24, 1978.
- 15. Air Force Regulation 23-8. <u>Air Force Systems Command</u>. Washington, D.C.: Department of the Air Force, October 31, 1975.
- 16. Air Force Regulation 800-2. Acquisition Program Management. Washington, D.C.: Department of the Air Force, November 14, 1977.
- 17. Air Force Regulation 800-4. <u>Transfer of Program</u> <u>Management Responsibility</u>. Washington, D.C.: Department of the Air Force, March 10, 1975.
- 18. Air Force Regulation 800-8. Integrated Logistics Support (ILS) Program for Systems and Equipment. Washington, D.C.: Department of the Air Force, July 27, 1972.
- 19. Air Force Systems Command Pamphlet 800-3. <u>A Guide For</u> <u>Program Management</u>. Washington, D.C.: Air Force Systems Command, April 9, 1976.
- 20. Air Force Systems Command Pamphlet 800-21. <u>A Guide</u> For Program Managers: Implementing Integrated Logistics Support. Washington, D.C.: Air Force Systems Command, June 18, 1974.
- 21. Air Force Systems Command Regulation 800-1. Command Review of Systems Acquisition Programs and Test Resources. Washington, D.C.: Air Force Systems Command, June 22, 1966.

- 22. Department of Defense Directive 4100.35. <u>Development</u> of Integrated Logistics Support for Systems/ <u>Equipment</u>. Washington, D.C.: Department of Defense, October 1, 1970.
- 23. Department of Defense Directive 5000.1. <u>Major System</u> <u>Acquisitions</u>. Washington, D.C.: Department of Defense, January 18, 1977.
- 24. Department of Defense Directive 5000.2. <u>Major System</u> <u>Acquisition Process</u>. Washington, D.C.: Department of Defense, January 18, 1977.

## Unpublished Material

- 25. Ellis, Major Jeffrey T. and Rougeau, Captain Joseph M. "Acquisition Management Handbook." Unpublished Air Command and Staff College research study, Air University, Maxwell Air Force Base, Alabama, 1976.
- 26. Neal, Lieutenant Colonel Clarke L. "Manpower Aspects of Integrated Logistics Support." Unpublished Defense Systems Management College research study, Defense Systems Management College, Fort Belvoir, Virginia, 1977.
- 27. Tetmeyer, Major Donald C., Moody, Senior Master Sergeant William D., and Nichols, Sharon R. "Simulating Maintenance Manning for New Weapon Systems: Manpower Programs." Unpublished Air Force Human Resources Laboratory research report, Headquarters Air Force Human Resources Laboratory, Brooks Air Force Base, Texas, 1974.
- 28. York, Major Michael L. "Maintenance Manpower as a Cost Consideration During Weapon System Acquisition." Unpublished Air Command and Staff College research study, Air University, Maxwell Air Force Base, Alabama, 1975.

