AD-A032 503 DEFENSE SYSTEMS MANAGEMENT SCHOOL FORT BELVOIR VA F/G 15/5
A MECHANIZED MANAGEMENT TOOL FOR INTEGRATING LOGISTICS SUPPORT.(U)
MAY 76 F L PUMROY

UNCLASSIFIED NL

1 OF 1
ADA032503

END

DATE
FILMED
1 -77

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

# REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

| | |
|---|---|
| 1. REPORT NUMBER | 2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle) | 5. TYPE OF REPORT & PERIOD COVERED |
| A MECHANIZED MANAGEMENT TOOL FOR INTEGRATING LOGISTICS SUPPORT. | Study Project Report, 76-1 |
| | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s) | 8. CONTRACT OR GRANT NUMBER(s) |
| Fredrick L. Pumroy | May 76 |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>Defense Systems Management College<br>Ft. Belvoir, VA 22060 | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS<br>67p. |
| 11. CONTROLLING OFFICE NAME AND ADDRESS<br>Defense Systems Management College | 12. REPORT DATE<br>76-1 |
| | 13. NUMBER OF PAGES<br>66 |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) | 15. SECURITY CLASS. (of this report)<br>UNCLASSIFIED |
| | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

UNLIMITED

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

SEE ATTACHED SHEET

DDC
RECEIVED
NOV 26 1976
A

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

SEE ATTACHED SHEET





DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

408 462

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEFENSE SYSTEMS MANAGEMENT SCHOOL

STUDY TITLE: A MECHANIZED MANAGEMENT TOOL FOR INTEGRATING LOGISTICS SUPPORT

STUDY PROJECT GOALS:

To determine the efficiency of present management information systems used to integrate logistics support. To discuss problems and factors associated with manual and computerized management information systems. To identify a standardized, efficient management tool for integrating logistics support in a System Program Office.

STUDY REPORT ABSTRACT:

The purpose of this study is to examine the integration of logistics support in the Air Force Weapon System acquisition process to determine the degree of efficiency demonstrated by the current management tools used for information systems. Several program offices were interviewed and used as the basis for the majority of viewpoints and real world issues presented in this study. In addition, informal interviews were made with several staff agencies to include Hq AFLC, Hq AFSC and Hq USAF. An attempt was made to transcribe the results of these interviews into the material presented in this study to clarify and present possible solutions to the problems and issues discussed in the text.

Examination of the tools and techniques used to manage information in the Systems Program Offices at Wright-Patterson AFB resulted in the determination that these systems are inefficient, inflexible, require excessive resources and are not standard.

A variety of management tools are discussed to compare their application to the weapon system acquisition process. It was determined that a manual management information system might be more cost effective in the conceptual phase, though a computerized system should be implemented beginning with the validation phase depending on the complexity of the applicable weapon system.

It was concluded that the Mark III computerized management system be implemented in the acquisition of weapon systems to integrate logistics support in the Systems Program Office. It is also recommended that the Mark III be expanded to total systems integration pending the success/cost effectiveness of the integrated logistics support interface.

KEY WORDS: Integrated Logistics Support, Mark III Management System
MATERIEL MANAGEMENT
MANAGEMENT SYSTEMS WORK BREAKDOWN STRUCTURES PROJECT MANAGEMENT
SYSTEMS ANALYSIS COMPUTERIZED SYSTEMS INTEGRATED LOGISTICS SUPPORT STANDARDIZATION

| NAME, RANK, SERVICE | CLASS | DATE |
| --- | --- | --- |
| Fredrick L. Pumroy, Major, USAF | PMC 76-1 | May 1976 |

# DEFENSE SYSTEMS MANAGEMENT SCHOOL

## PROGRAM MANAGEMENT COURSE
## INDIVIDUAL STUDY PROGRAM

A MECHANIZED MANAGEMENT TOOL
FOR INTEGRATING LOGISTICS SUPPORT

STUDY PROJECT REPORT
PMC 76-1

Fredrick L. Pumroy
Major USAF



FORT BELVOIR, VIRGINIA 22060

# A MECHANIZED MANAGEMENT TOOL FOR INTEGRATING LOGISTICS SUPPORT

Study Project Report

Individual Study Program

Defense Systems Management School

Program Management Course

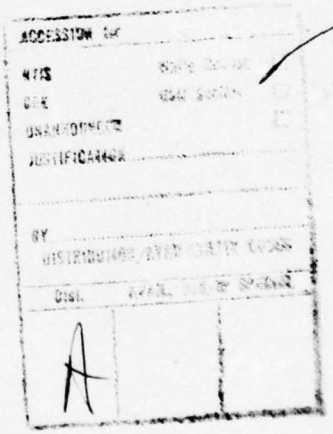
Class 76-1

by

Fredrick L. Pumroy
Major USAF

May 1976

Study Project Advisor
LCDR Susan A. Anderson, USN



## EXECUTIVE SUMMARY

Integrated Logistics Support (ILS) is becoming more and more important in the systems acquisition process. Concurrently, support tasks have also been the most difficult and expensive to interface with the devlopment aspects of a program. Therefore, this study primarily concentrates on the problems and issues involved with ILS while recognizing that the management tools and techniques discussed could be applicable to all areas of management in the weapon system acquisition process.

A variety of management tools and techniques are identified as principle management information systems currently being used to integrate logistics support in systems program offices at Wright-Patterson AFB. Several of these systems are discussed with the purpose of identifying the pros and cons of the major categories being used, i.e., Gantt charts, milestone charts, PERT networks, critical path networks, and the MARK III systems.

The report concentrates on the application of the Mark III Management System and associated factors to be aware of during the implementation of the system in terms of resources and human factors. Successful implementation of the Mark III system on the B-1 and F-16 is discussed to include some of the problems experienced during the initial introduction to the system.

In comparing the advantages of the Mark III Management System against the other management information systems currently being used, it was concluded that the Mark III system meets the objective set forth in this study. The objective being to identify a management tool which is standardized, efficient and meets DOD established goals while remaining flexible, simple, and economical. Therefore, it is recommended that the Mark III Management System be implemented in the acquisition of weapon systems tc integrate logistics support in the Systems Program Office while considering the feasibility of using the Mark III system for total system acquisition.

ACKNOWLEDGEMENTS

This section is dedicated to all the individuals who so unselfishly gave their time to discuss the problems and issues discussed in this study.

A special thanks goes to LCDR Susan Anderson who so patiently steered my efforts in the right direction.

I would also like to express special appreciation for the extra effort and cooperation received from Lt Col Hennigan (B-1 DPML), Lt Col Stempson (Hq AFLC/AQML) and Mr. Jay Kavanagh (Program Control Corporation).

TABLE OF CONTENTS

# SECTION I

# INTRODUCTION

## General

Each year management of research, engineering and support of complex projects poses an increasingly difficult challenge to executives and managers at all levels. This challenge is compounded not only by the growing technological complexity of these projects, but also by the stern demands of government officials at all levels for improved management performance and by the insistent demands of the Department of Defense (DoD) for control of costs and schedules - all without compromise in product performance or quality.

These requirements have led to the generation of numerous management information and control systems designed to assist managers in generating plans and schedules, applying resources, and evaluating schedule, cost, and performance progress. Some of these systems have been based on PERT, PERT/COST, and CPM (Critical Path Method). Whether implemented manually or with computers, the methods developed in recent years have been useful. Computers in particular have enabled the managers of modern enterprises to achieve significant advances in their ability to manage very large, complex programs involving many skills and thousands of interrelated tasks.

The result to-date has been a rapidly growing volume of computer-produced data. However, this wealth of computer data has created a

paradox. The purpose of generating this data is to save manhours, which it does in numerous ways; but the act of using the data effectively has now become so time-consuming and tedious for the manager that this in itself has become a significant problem.

## Purpose

The purpose of this study is to review Integrated Logistics Support (ILS) offices in major Air Force weapon systems to determine whether present management tools used for total systems integration are efficient. This study will identify problems and factors concerning the implementation of computerized management systems. The study will also discuss the varied aspects of non-standard and standard management systems. In conclusion the paper will recommend a management tool for use by all levels of management.

## Problem Definition

One of the most costly problems within the Department of Defense today is the inefficiency of management information systems throughout the military complex. As a result of obsolete and unrelated data several major programs have had to slip schedules, delay support planning, delete invaluable test and evaluation tasks and modify other critical/areas to live within budget constraints. Therefore, this study will be concentrated on problems and issues related to managing information within the Air Force.

## Scope

This study is limited to the logistics support interface within Air

Force System Program Offices (SPO) due to the magnitude of management infomation systems even when confined to a SPO organization. Quantification of methods or recommendations with this study will not be attempted due to insufficient comparable data. The study will primarily be comparing today's methods of integrating logistics support in the SPO to using a computerized program as a standard management tool for project management decision making. The reader should also be aware that the principles and techniques addressed in this study are generally applicable to all project office organizational structures.

## Objective

The objective of this study is to identify a management tool for integrating logistics support in a SPO which is standardized, efficient, and meets DoD established goals while remaining flexible, simple and economical.

## Methodology

This study was based on personal discussions and telephone interviews with cognizant personnel in Hq, AFLC, Systems Program Offices, Hq, USAF, as well as other DoD personnel. Reference materials were obtained from Hq AFLC, the library at the Defense Systems Management School and the Program Control Corporation, Van Nuys, California.

## Definition of Terms

This study assumes the reader has a thorough knowledge of terms related to the systems acquisition environment. Terms unique to this

study are defined in the text. An exception is the use of PM and LM. For clarity purposes PM will refer to the systems program director responsible for the total program and LM will refer to the Director of Logistics or Deputy Program Manager for Logistics responsible for logistics implications within the systems program office.

Organization of Research and Report

Section 1 includes a general introduction, purpose of study, problem definition, scope, objective of study, methodology, definition of terms, and organization of the study.

Section 2 discusses the background of Integrated Logistics Support (ILS) and its evolution in the DoD complex. It provides a basic framework for discussion of the following sections.

Section 3 outlines the different management tools used to integrate logistics support planning into the total program management system. This section also compares the non-standard information flow with the standard information system emphasizing the advantages or disadvantages of each.

Section 4 presents an overview of the Mark III management information system which is currently being utilized at Wright-Patterson AFB (WPAFB) on a limited basis.

Section 5 discusses the application of the Mark III system on an AF-wide scope and the varied uses the system offers as a management tool for all levels of management. The section also examines the implications of Mark III application in terms of resources and human factors.

Section 6 examines the problems and issues experienced during implementation of the Mark III Management System on the B-1 and F-16 programs.

Section 7 presents conclusions and recommendations derived by the author from the accumulated data discussed in this study.

## SECTION II

## BACKGROUND

### Early DoD Policy on Integrated Logistics Support (ILS)

Early Department of Defense goals recognized the importance of logistics support planning during the systems acquisition process as indicated in DoDD 3232.1, November 3, 1955. The subject of this directive was DoD Maintenance Engineering Program. There was concern throughout the Department of Defense during this time period over the increasingly complex hardware and the associated impacts on the maintenance of the equipment. The following excerpt from DoDD 3232.1 expresses this recognition.

> "The Department of Defense is acquiring and utilizing progressively larger quantities of material of increasing complexity and cost. The highly developed maintenance activities of the Military Departments have recognized, to a large degree, the impact of these significant inventory changes upon their capabilities. However, in view of the extent to which effective maintenance of this material is generating continually increasing demand for resources (funds, skilled manpower, materials, facilities and tooling) even greater emphasis is necessary on the policy direction, technical supervision and management control of major maintenance programs and activities." (9:3)[1]

[1]This notation will be used throughout the report for sources of questions and major references. The first number is the source listed in the bibliography. The second number is the page in the reference.

Though greater emphasis was placed on maintainability, the proper management tools for implementing this approach were still lacking. Not until 1964, did the military and DoD discover that logistics support incompassed more than just maintainability. On June 19, 1964, DoD 4100.35 was published and initiated the evolution of (ILS) as indicated in the following statements.

From page one:

> "This Directive defines integrated logistics support, establishes Department of Defense policies and objectives governing the systematic and orderly development of integrated logistic support for systems and major items of equipment, and assigns responsibilities for carrying out the program." (10:1)

From page two:

> "The primary objective of this Directive is to assure that the development of effective logistic support for systems and equipments is systematically planned, acquired and managed as a whole (by interlocking the elements of logistic support) to obtain maximum material readiness and optimum cost effectiveness." (10:2)

An attempt was made to implement the intent of the DoD directive through early program office manuals such as AFSCM 375-3 and 375-4, though the procedures of these manuals provided logistics support too late. As a result reliability and maintainability, two key inputs to life cycle cost considerations, were not identified at appropriate times.

After reorganization of the Air Force Air Material Command in 1961, communication problems between Air Force Systems Command and Air Force Logistics Command began to arise. To correct this situation the Commanders of AFSC and AFLC formally notified their respective staffs of the importance of intercommand cooperation. (4:33) Also, the Air Force Chief of

Staff, in explaining the acquisition policy for the 70's stated:

> "We will be getting the Logistics Command into the act early in the systems acquisition. Log Command people will be assigned to the System Command Program Offices to insure integrated logistics support." (8:13)

Current DoD Policy on Integrated Logistics Support

Some of the changes made since 1970 include reorganization and new directives.

Beginning with the F-15 Program all major system program offices have full time Deputy Directors for Logistics or Deputy Program Managers for Logistics (DPML) as referred to by AFLC. With this level of authority in the SPO chain of command, a strong link of communication has been established to break the barrier of deficient logistics support. See attachment II-1, for a normal SPO organization. Even less-than major programs now have liaison representatives from AFLC DCS/Acquisition Logistics to work with the Systems Command at all levels to identify logistics requirements in the planning of systems. (1:65)

Several new DoD and AF directives have been developed to ensure the program offices consider the intergration of logistics support into their programs in perspective of the total system and its environmental relationships. Some examples of current policy are addressed as follows:

AFSCR/AFLCR 400-10:

> "...Command responsibilities for logistics functions to be accomplished in Air Force system programs and establishes a deputy system program director for logistics and an integrated logistics support division within the system program office (SPO) for system destined to enter the operational inventory." (5:1)

# SINGLE BASIC SYSTEM PROGRAM OFFICE

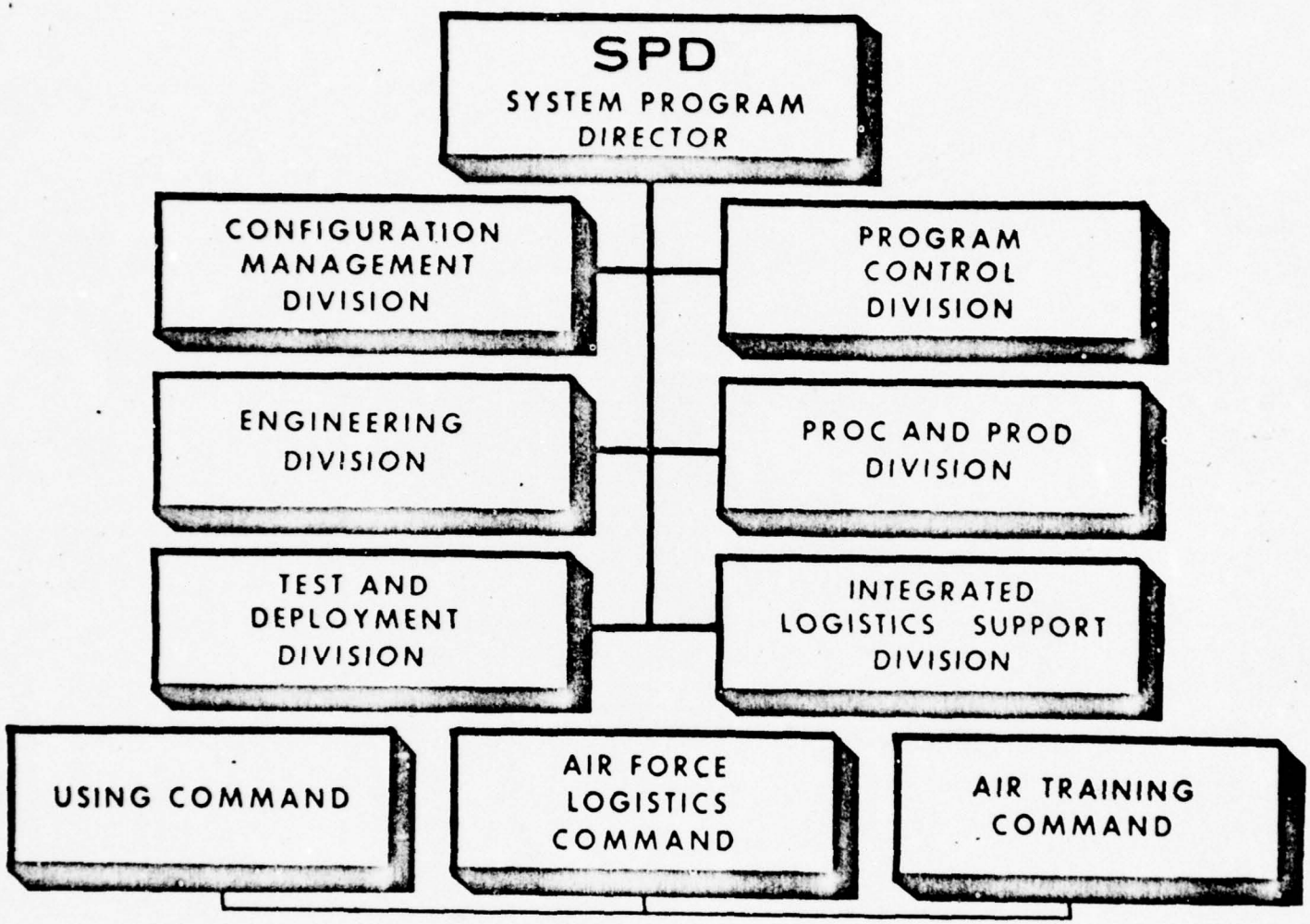



Fig. II-1

AFP 800-7:

"The function of the Integrated Logistic Support Plan (ILSP) is to identify the actions to be accomplished, assign responsibilities, and establish milestones. It accounts for the interaction of events and activities, provides for government/contractor management and review policies, establishes logistic support management information reporting requirements, and provides for the definition, integration, and subsequent acquisition of the support elements. Initial planning must be sufficient to establish the scope of ILS activities for the initial phase of the acquisition process, and is generally limited to the consideration of special problems. During each phase the level of detail in ILS planning must be sufficient to provide support for equipment which is deployed or utilized during that phase. It must establish scope and depth of activities to be accomplished in the succeeding phase and should make provisions for an orderly transition to the succeeding phase. Careful attention must be given to lead time requirements and to ILS activities which are prerequisites to events occurring in other support elements (e.g., establish maintenance concept before designating support and test equipment." (2:4-5)

DoDD 4100.35:

"Integrated Logistics Support - Integrated logistic support is a composite of all the support considerations necessary to assure the effective and economical support of a system for its life cycle. It is an integral part of all other aspects of system acquisition and operation. Integrated logistic support is characterized by harmony and coherence among all the logistic elements. The principal elements of integrated logistic support (defined in reference (b) related to the overall system life cycle include:

1. The Maintenance Plan
2. Support and Test Equipment
3. Supply Support
4. Transportation and Handling
5. Technical Data
6. Facilities
7. Personnel and Training

8. Logistic Support Resource Funds

9. Logistic Support Management Information

> It shall be the responsibility of the Integrated Logistic Support function to provide recommended support parameters for the above elements. Such parameters shall be provided as quantitative maintainability and reliability inputs to the design process for use in design trade-offs, risk analyses and development of a logistic support capability responsive to the operational requirements of the weapon systems." (11:2-3)

As you can see from the study thus far logistics implications are becoming more critical in the realm of systems program management due primarily to the lack of defense dollars available and to the fact that operations and support costs are exponentially high in the "out-years" of a system. Logistics problems have to be identified as early as possible in the acquisition process since approximately 70 percent of the design is locked-in by the end of the conceptual phase as shown in Figure II-2.

# PHASING OF SYSTEM DECISIONS DEFINING TOTAL LCC

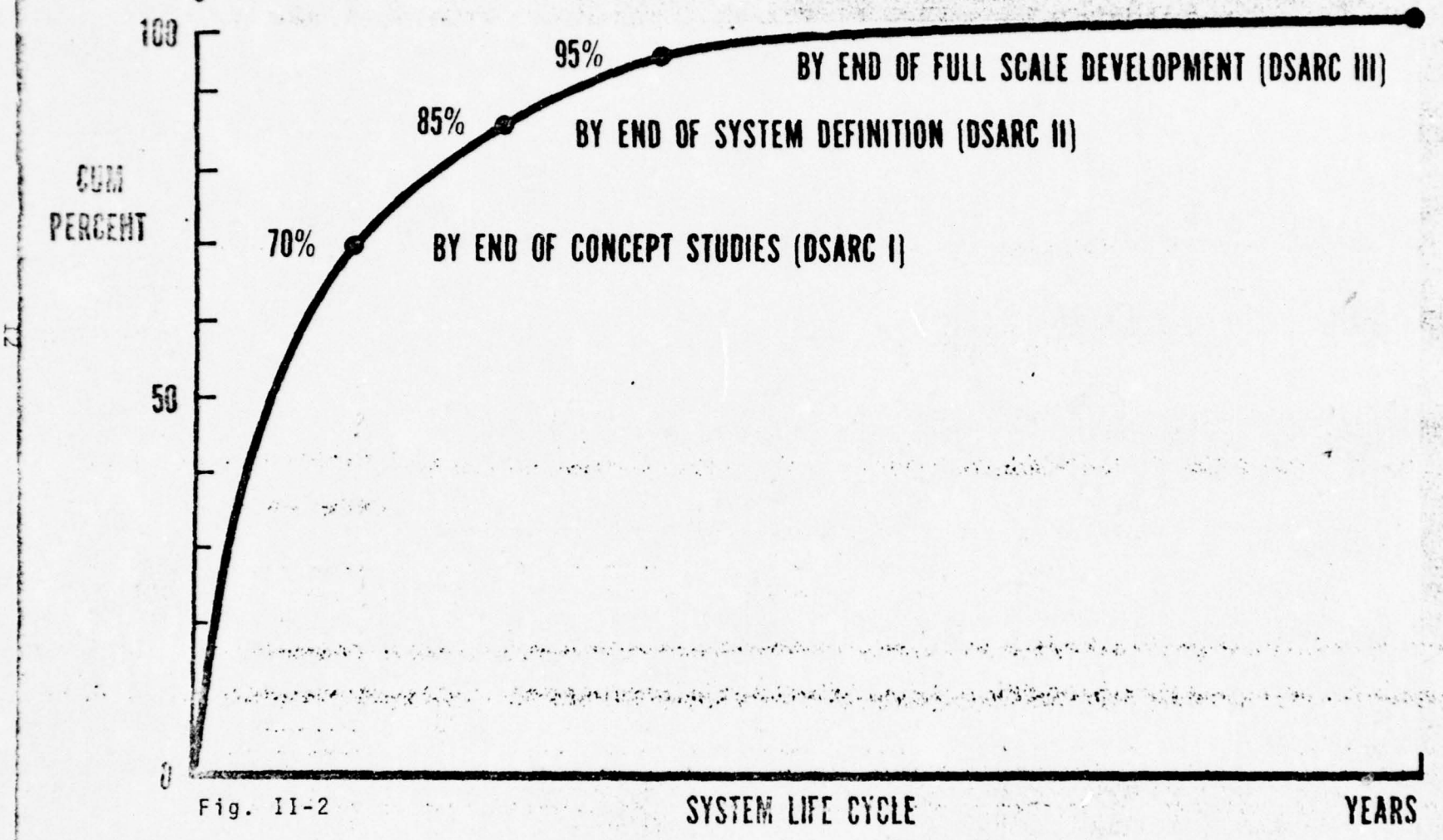



Fig. II-2

## SECTION III

## MANAGEMENT OF INTEGRATED LOGISTICS SUPPORT PLANNING

### Management Systems Used by the Integrated Logistics Support Office (ILSO)

Logistics Managers (LM) in the Systems Program Office (SPO) principally utilize several different management techniques in the management of their areas of responsibility. The initial thrust of this section will be to provide an insight into the more common management techniques currently in use.

Some LM's employ a system of management which will be termed the "limited documentation" technique for the lack of a formal title. Basically, this method involves minimal use of the more formalized methods of scheduling, resource forecasting, control and reporting. The manager relies heavily on his experience level, and the program's overall planning is performed primarily in the minds of the manager and a few key personnel. For the most part, formal documentation takes the form of required reports or as responses to the specific queries.

A more formalized method of management involves the use of Gantt type milestone charts, principally for planning tasks to be accomplished within a specified time-frame. The Gantt chart is an effective means of scheduling, but it is not particularly effective in showing the relationships between milestones comprising of the same task or in allocating and

tracking resources. This method is the primary management tool currently being used by ILSOs in their Integrated Logistics Support Plans. An example of a contractor developed milestone chart for the F-15 ILSP is shown in Figure III-1 and an Air Force or "in-house" ILSP for the F-16 in Figure III-2. As you can see both examples are manual techniques and represent the current format for ILSPs in the Air Force which are required for each acquisition program. The main deficiencies imposed by these manual ILSPs are: they duplicate other planning documents, quite often contain obsolete information due to excessive coordination and distribution times required and do not identify task interfaces.

The Program Evaluation and Review Technique (PERT) is utilized by some LMs. PERT is essentially a planning and control method which utilizes a network for scheduling and limited resource allocation in order to accomplish activities in accordance with a time schedule. One of the advantages of PERT is its technique of highlighting problem areas. To a limited degree PERT can be utilized for resource allocation, such as in forecasting costs. (7: 114-115). PERT can be computerized and a compatable computer program is available at Wright-Patterson AFB, Ohio. However, at WPAFB, PERT is used more in its time and schedule application than in its resource allocation mode. In operation, PERT is often complicated and time-consuming, and unless it is highly computerized, relatively small changes can precipitate laborious, complex and far-reaching adjustments in its network.

The Mark III Management System (Mark III) is utilized for some programs at WPAFB. Virtually all of the projects within one basket SPO use

## F-15 PROGRAM SCHEDULE

TITLE: MAINTENANCE PLANNING

ASSIGNMENT: 5110 5200 5260

SCHED ◇ ACTUAL ◆ SCHEDULE EVENT ◇ RESCHEDULED EVENT ◆ TIME SPAN ACTION ◇—◇ PROGRESS ALONG TIME SPAN ◆—◆ CONTINUOUS ACTION ◆→ ★ DEMONSTRATION MISSIONS

| | NOMENCLATURE | WBS | ACTION |
|---|---|---|---|
| 1 | PROGRAM EVENTS | | |
| | | | |
| 2 | ISSUE MAINT PLAN/FORECAST | 6310 | MCAIR |
| | | | |
| | MAINTENANCE ANALYSIS PROGRAM | | |
| | PREPARE PRELIMINARY EIMS | | |
| 3 | AVE | 5112 | MCAIR |
| 4 | OB/AGE | 5112 | MCAIR |
| 5 | DEPOT AGE | | |
| | PREPARE FIRM EIMS (M) | | |
| 6 | AVE | 5112 | MCAIR |
| 7 | OB/AGE | 5112 | MCAIR |
| 8 | DEPOT AGE | 5112 | MCAIR |
| 9 | MTS | 5112 | MCAIR |
| | | | |
| | MAINTENANCE VERIFICATION | 5112 | MCAIR |
| 10 | AT MCAIR | 5112 | MCAIR |
| 11 | AT SUPPLIER'S FACILITY | 5112 | MCAIR |
| 12 | AT CAT I TEST SITE | 5112 | MCAIR |
| 13 | IMPLEMENT MAINTENANCE DATA COLLECTION (CAT. I FLT TEST) (M) | 5113 | MCAIR |
| 14 | COMPLETE DOT AND E MAINTENANCE ANALYSIS (M) | 5112 | MCAIR |
| | | | |
| | MOBILE SUPPORT REQUIREMENTS PROGRAM | | |
| 15 | UPDATE MOBILITY PLAN | 5260 | MCAIR |
| 16 | RECOMMENDED WRSK A/C SPARES LIST AVAILABLE | 6400 | MCAIR |
| 17 | RECOMMENDED WRSK AGE SPARES LIST AVAILABLE | 6400 | MCAIR |
| 18 | SUBMIT PROPOSED WRSK LIST | 6400 | MCAIR |
| 19 | MEEPAK AGE LIST AVAILABLE | 6400 | MCAIR |
| 20 | MEEPAK FACILITY LIST AVAILABLE | 6400 | MCAIR |
| 21 | MEEPAK PERSONNEL LIST AVAILABLE | 6400 | MCAIR |
| 22 | SUBMIT PROPOSED MEEPAK | 6400 | MCAIR |
| 23 | SUBMIT T.O. LISTS (ILSAT MAINTENANCE SHOPS) | 5260 | MCAIR |
| 24 | PRESENTATION ON MOBILITY ACHIEVEMENT | 5260 | MCAIR |

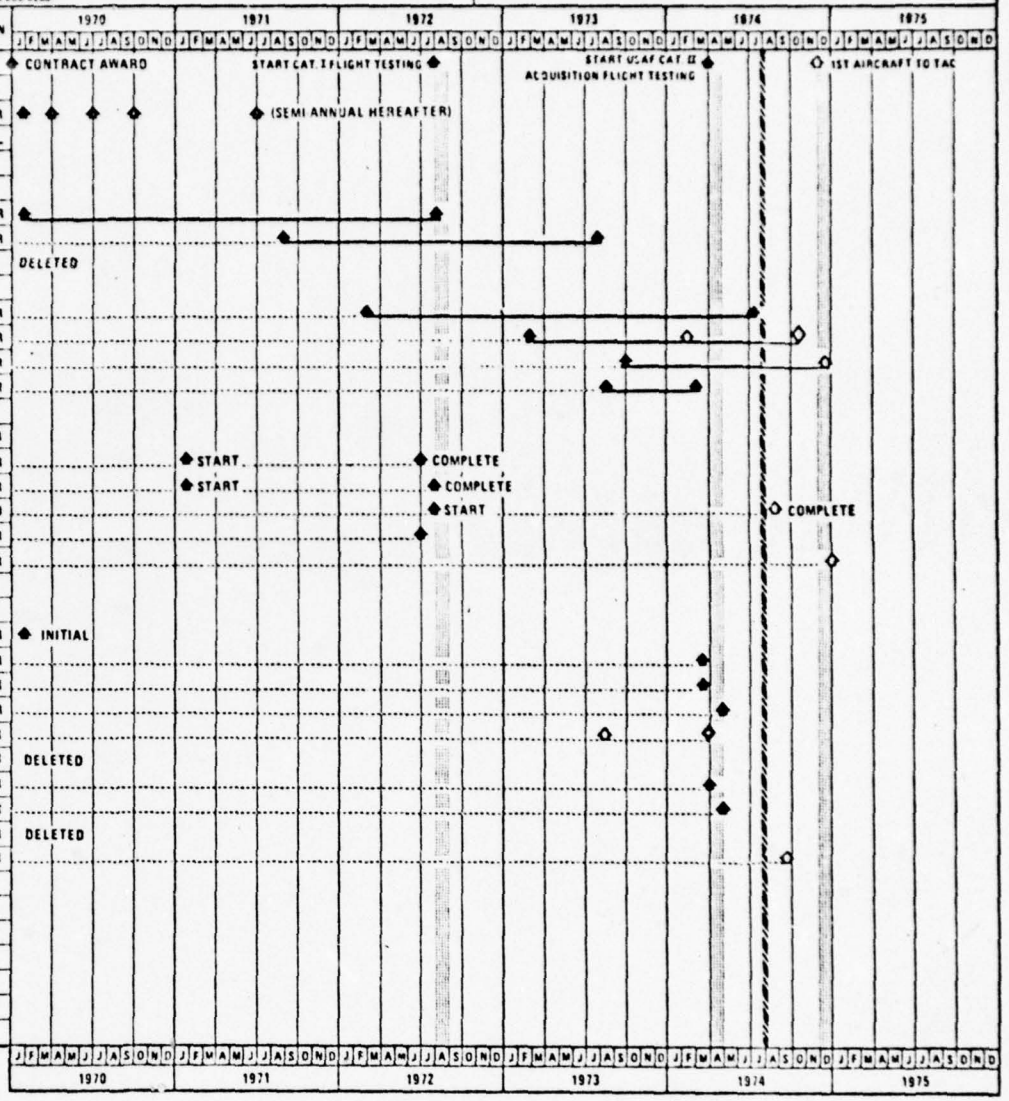



Fig. III-1

MCDONNELL AIRCRAFT COMPANY

SECTION 5
MAINTENANCE PLAN

OO/ALC(MMH)

16. PAGE
PAGE OF PAGES

7. PROGRAM ELEMENT
MP

FY 19 | FY 19 | FY 19 | FY 19 | FY 19 | FY 19 | FY 19

CALENDAR YEAR 1976 | CALENDAR YEAR 1977 | CALENDAR YEAR 1978 | CALENDAR YEAR 1979 | CALENDAR YEAR 1980 | CALENDAR YEAR 1981

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

8. MILESTONE EVENT

1ST FSD DEL — DSARC — 1ST PROD DEL — IOC

EVALUATE MAINT SYS AGAINST CRITERIA IN SPEC & CONTRACT — 1

INSURE MAINT PLAN MATCHES DESIGN BASELINE — 2

DEV MAINT SUPPORT RESOURCES ON SYS & COMPONENTS BASED ON LSA OUTPUTS — 3

AIR FORCE ASSUMES ORGAN.MAINT RESPONSIBILITIES — 4

AIR FORCE ASSUMES INTERMEDIATE MAINT RESPONSIBILITIES — 5

EVALUATE CONTRACTOR CONDUCTED MAINT DEMONSTRATIONS — 6

UPDATE MAINT PLAN — 7

INTEGRATE MAINT PLAN IN ILSP — 8

PRESENT PLAN TO USER — 9

GOVERNMENT-CONDUCTED OPERATIONAL SUITABILITY DEMONSTRATION — 10

MAKE APPROPRIATE TRADE-OFFS ON NOTED DEFICIENCIES — 11

REVISE MAINT PLAN IN ACCORDANCE WITH CHANGE RECOMMENDATIONS — 12

AFLC FORM 504 AUG 73

SYSTEM PROGRAM MILESTONE EVENT CHART

AFLC-WPAFB-NOV 73

Fig. III-2

the Mark III, and a few other programs, such as the B-1 and F-16 ILSOs, use the system. The Mark III is a computerized management system which employs the advantages of both Gantt and PERT techniques. Further, the Mark III provides a much more extensive projection of resource requirements than the systems previously described. Inasmuch as the system was designed for computer application, it is much easier to computerize its inputs than to automate PERT. As a result the computer performs much of the laborious effort which is frequently associated with PERT.

Before completing discussion of the principal management methods utilized by the ILSOs, it is important to recognize that there are combinations which exist even within the relatively small numbers of methods which have been presented. For instance, one LM considers the optimum technique as applying the Gantt milestone method in the conceptual phase of the program when the basic tasks and scheduling are being developed. This same manager prefers the Mark III technique once the program has progressed beyond the planning stage. Obviously, even the relatively informal "limited documentation" method possibly involves the use of Gantt or PERT applications on occasion. The distinction to be made is that variations exist; a program has been identified as utilizing a certain management tool because it uses that system to an appreciable degree and as its principle management technique.

Nonstandard Information Flow

The nonstandardization of management tools in the ILSO has an impact on the information available to the different levels of management. At

present, much of the program information used for reports above the project level must be manually extracted, examined and standardized to ensure it is responsive to the user's need, collated, and reviewed at each level of management. This process results in great expenditures of resources and material unnecessarily. Information required to meet the needs of higher management is frequently not being maintained concurrent with program information needs, or the information exists in forms which are not readily usable by higher management. This presents the same dilema to the Air Force that faces many decentralized organizations. On the one hand, it is difficult to deny the primacy of maintaining information in a form which is usable to the manager. On the other hand, the importance of ensuring the availability of meaningful information above the program level cannot be denied.

The paradox outlined in the previous paragraph is susceptable to improvement through the standardization of management information requirements. Fundamentally, this requires that information needed by higher management be maintained by program office personnel in forms which are usable to higher management. Similarly, higher management has the responsibility to utilize the information in the standardized form and from available resources. (20)

The advent of the computer has facilitated the merger of seemingly diverse information requirements of middle and upper management. As an example, information being maintained in considerable detail at lower management levels can be processed by the computer to provide information in a summarized form useful to upper management.

Even the admittedly small number of discussions conducted with ILS personnel at WPAFB revealed that the preparation of information for reports is of real concern to these personnel. It was recognized that highly automated and effective systems provide much of the financial and personnel information in the Air Force. However, without increased standardization of management tools, appreciable improvement in information system effectiveness seems remote.

A Standard Information System

While looking at the IM level of the SPO, it was found that no one management information system was being used either up and down the chain of command or across different projects, but various systems ranging from the minimal to the most sophisticated were utilized. This nonstandardization of information and management does provide a certain amount of latitude which is desirable in the creative environment of the Program office mission. Nevertheless, considering that improving the overall effectiveness of information available to management is a desirable goal which, when seriously considered, seems to support the premise that standardization is necessary.

Standardization of program information would appear to offer a number of advantages in addition to improving information effectiveness. Once implemented, standardization should reduce the information demands placed by higher management on program office personnel. The same information which program personnel maintain and utilize for their management purposes, once standardized, should satisfy most of the needs of higher

management. This also should eliminate a good deal of the burden placed on program personnel by their having to provide essentially the same information repeatedly. Some additional information of interest to higher management only, might have to be maintained, but this should be minimal in relation to what would be gained from the elimination of duplication and manual information processing.

As previously identified, standardization would provide the opportunity for a greater automation of information. Additionally, standardization would provide the key in the development of a computerized data base. Not only would this provide the basis for the extraction of information by all levels of management, it also would provide for automated reports and for accepting ad hoc requirements. The resulting information would be structured to be particularly meaningful to the user. With minimal disruption, information would also be available to respond to requestors outside the program office.

Nonstandardization of information requirements is troublesome to personnel whose duties require they work on different programs concurrently. Standardization would remove the necessity for program personnel to learn the intricacies of a number of management systems. Much the same parallel exists with respect to program reviews and status briefings by higher management. Standardization of program management information systems would facilitate review and make the identification of trade-offs and alternatives much less difficult.

In summation, standardization of information systems in the Air Force

would improve information efficiency and effectiveness. Standardization of information and management tools appear to be intricably related and can be tailored to the diversity of current program management methods. After being briefed on the Mark III system it appeared to be an outstanding tool for the LM due to the nature of the program office mission; therefore, a more in depth examination of the Mark III System will be accomplished to determine its application as a standard management tool for the ILSO within program offices at WPAFB.

## SECTION IV

## THE MARK III MANAGEMENT SYSTEM

### Description

The Mark III is a computerized management system specifically designed and developed for use in the management of complex projects of all sizes in fields such as: applied research, development engineering, defense systems development, building construction, real estate development, motion picture production, and shipbuilding. (21:1) The Mark III system was developed by E. Boyan and M. James during the early 1960's and they formed the Program Control Corporation (PCC) to market their new system. The Mark III is available from PCC under various contract options which will be discussed later in this section. Presently, the Air Force has a full service contract with PCC which provides Mark III for several programs at WPAFB The following paragraphs give a brief description of Mark III operations along with associated capabilities. (15)

The Mark III itself is a computer program which manipulates the input data and produces various outputs which allow the manager to plan, schedule, allocate resources and monitor his program. The inputs required by the Mark III are basically the same as for a PERT program but with more detail for resource requirements of a project. The Mark III provides an iterative planning process which starts with a simple definition of the major fields of effort involved in the project. Then

each field of effort is subdivided into smaller fields of effort until every activity or task that must be completed to finish the project is defined. Each activity is named and numbered with a description of all interfaces that activity has with other activities. In a PERT System, only preceding activities are defined, while the Mark III allows for partial interfaces ($A_1$ requires 50% of $A_2$) and required concurrent activities ($A_2$ must run concurrent with $A_3$) as well as the standard proceding activity interfaces. Also, the estimated time to accomplish each activity is required along with an estimate of resources that will be required for each activity. The resources are divided into two categories; material and service, and manpower. The material and service resources are represented in dollars and the manpower resources are presented by the actual number of personnel. The manpower resource can be furthered subdivided into skill codes, if desired. Once the above information is gathered, it is put into the input card deck and fed into the computer. (15)

The above mentioned data provides all the information that the Mark III program needs to calculate and lay out a complete and accurate schedule of tasks and resources plotted against a calender time scale. With Mark III, it is not necessary to hand draft or produce any type of logic diagram, such as a PERT network, prior to computer input. The computer program generates a plotter tape or card deck which is placed off-line on a digital plotter to plot the desired outputs. The graphic outputs are basically of two types: activity charts and resource graphs. The following is a list of the more frequently used outputs with a brief description of each:

1. Detailed Activity Chart - (Figure IV-1a,b,c): This chart is the key output of the Mark III. It displays and integrates the following fields of information: activities and milestones, calender schedule, schedule progress, critical path, interfaces and resources. The characteristics of each activity are carried on one horizontal line and are displayed in order from left to right following the activity description and its alphanumeric designator. (21:17)

2. Summary Activity Chart - (Figure IV-2a,b): These charts can be used at the manager's discretion to summarize large blocks of work for his use or for forwarding to higher level management. Summaries can range from a single line summarizing the entire program to a detailed summary as specified by the program managers. (21:17)

3. Selective Sort Chart - These are charts which cover only selected activities as designated by the program manager. These are useful for close control over critical areas. Also, if a portion of the program is the responsibility of another organization, a selective sort could be used to give that organization a chart of its independent activities. (21:17)

4. Resource Graphs - (Figure IV-3a,b): The Mark III performs a number of significant computations pertaining to schedule/cost/manpower relationships and displays the resultant data in the form of resource graphs. Resource graphs can be obtained for an entire program or for as many sub-elements or subgroups of a program as desired. These graphs can be in the form of a histogram or a cumulative curve as shown in

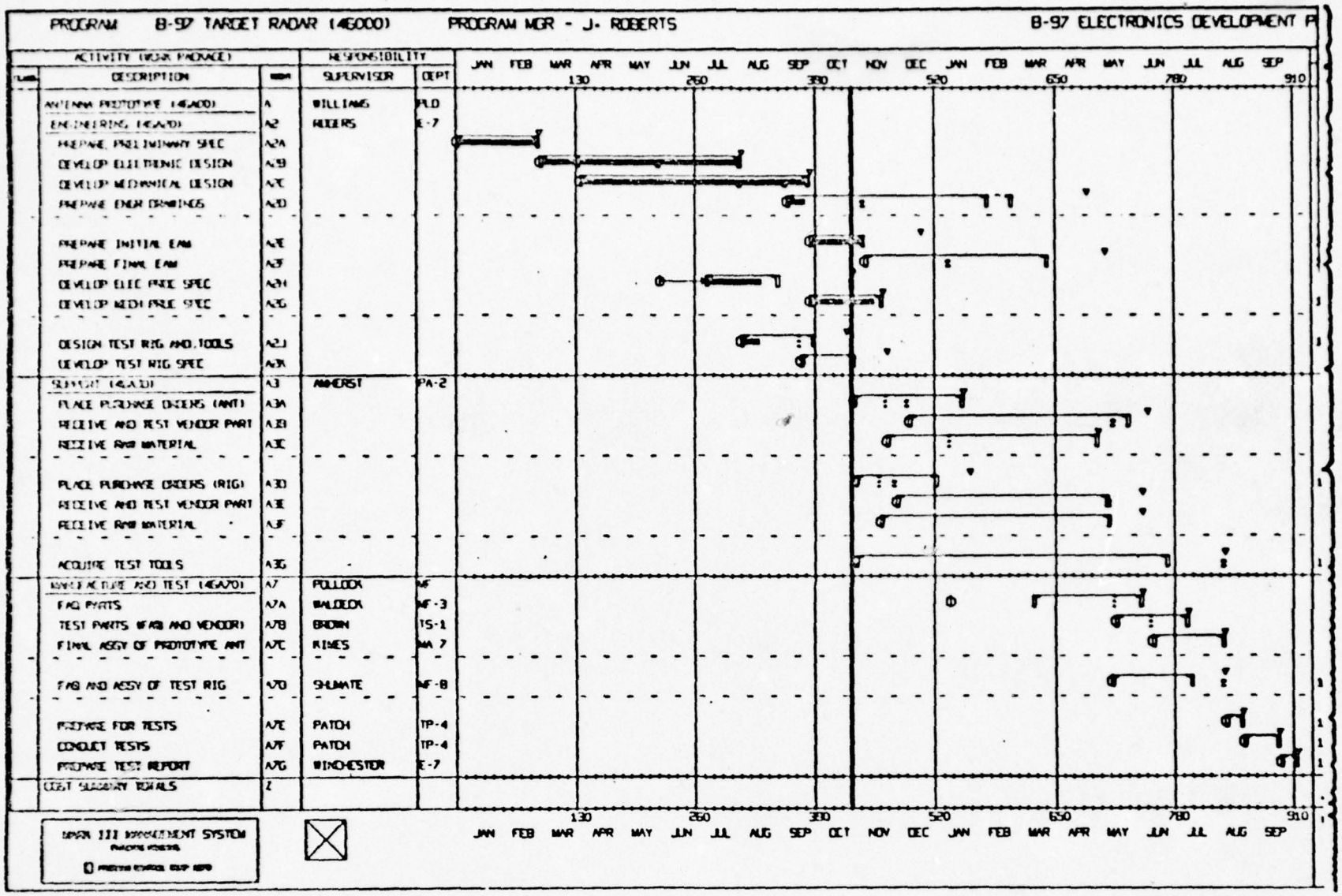

PROGRAM B-97 TARGET RADAR (46000)
PROGRAM MGR - J. ROBERTS
B-97 ELECTRONICS DEVELOPMENT P
ACTIVITY (WORK PACKAGE)
RESPONSIBILITY
DESCRIPTION
SUPERVISOR
DEPT
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP
130 260 390 520 650 780 910
ANTENNA PROTOTYPE (46A00)
ENGINEERING (46A10)
PREPARE PRELIMINARY SPEC
DEVELOP ELECTRONIC DESIGN
DEVELOP MECHANICAL DESIGN
PREPARE ENGR DRAWINGS
PREPARE INITIAL EAM
PREPARE FINAL EAM
DEVELOP ELEC PROC SPEC
DEVELOP MECH PROC SPEC
DESIGN TEST RIG AND TOOLS
DEVELOP TEST RIG SPEC
SUPPORT (46A30)
PLACE PURCHASE ORDERS (ANT)
RECEIVE AND TEST VENDOR PART
RECEIVE RAW MATERIAL
PLACE PURCHASE ORDERS (RIG)
RECEIVE AND TEST VENDOR PART
RECEIVE RAW MATERIAL
ACQUIRE TEST TOOLS
MFG ACQUIRE AND TEST (46A70)
FAB PARTS
TEST PARTS (FAB AND VENDOR)
FINAL ASSY OF PROTOTYPE ANT
FAB AND ASSY OF TEST RIG
PURCHASE FOR TESTS
CONDUCT TESTS
PREPARE TEST REPORT
COST SUMMARY TOTALS
WILLIAMS
ROGERS
AMHERST
POLLOCK
WALDECK
BROWN
RINES
SHUMATE
PATCH
PATCH
WINCHESTER
PLD
E-7
PA-2
MF
MF-3
TS-1
MA 7
MF-8
TP-4
TP-4
E-7

Fig. IV-1a

**Chart Continued from Previous Page. To Achieve Proper Effect, Line Up Both Segments**

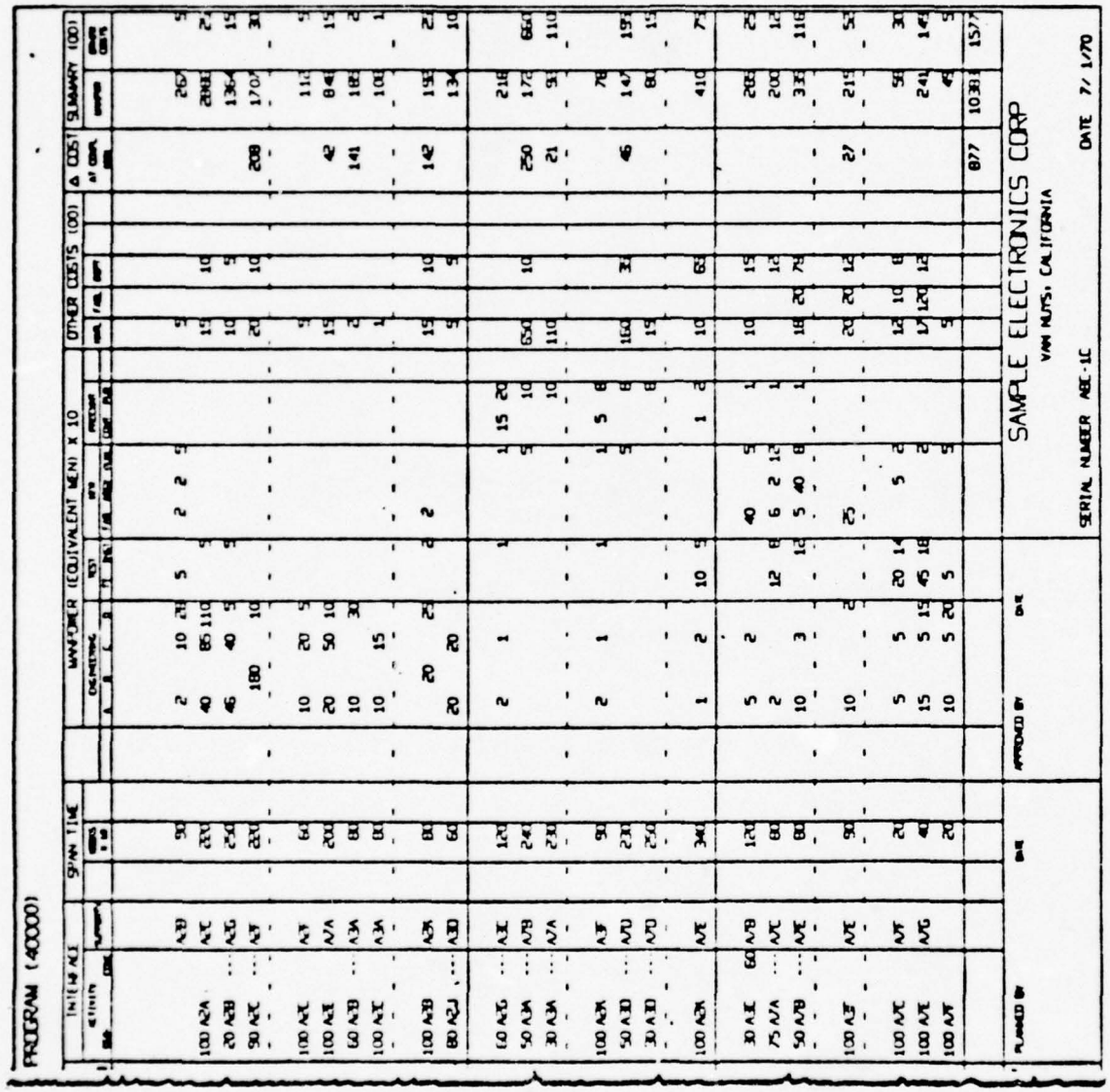



Fig. IV-1b

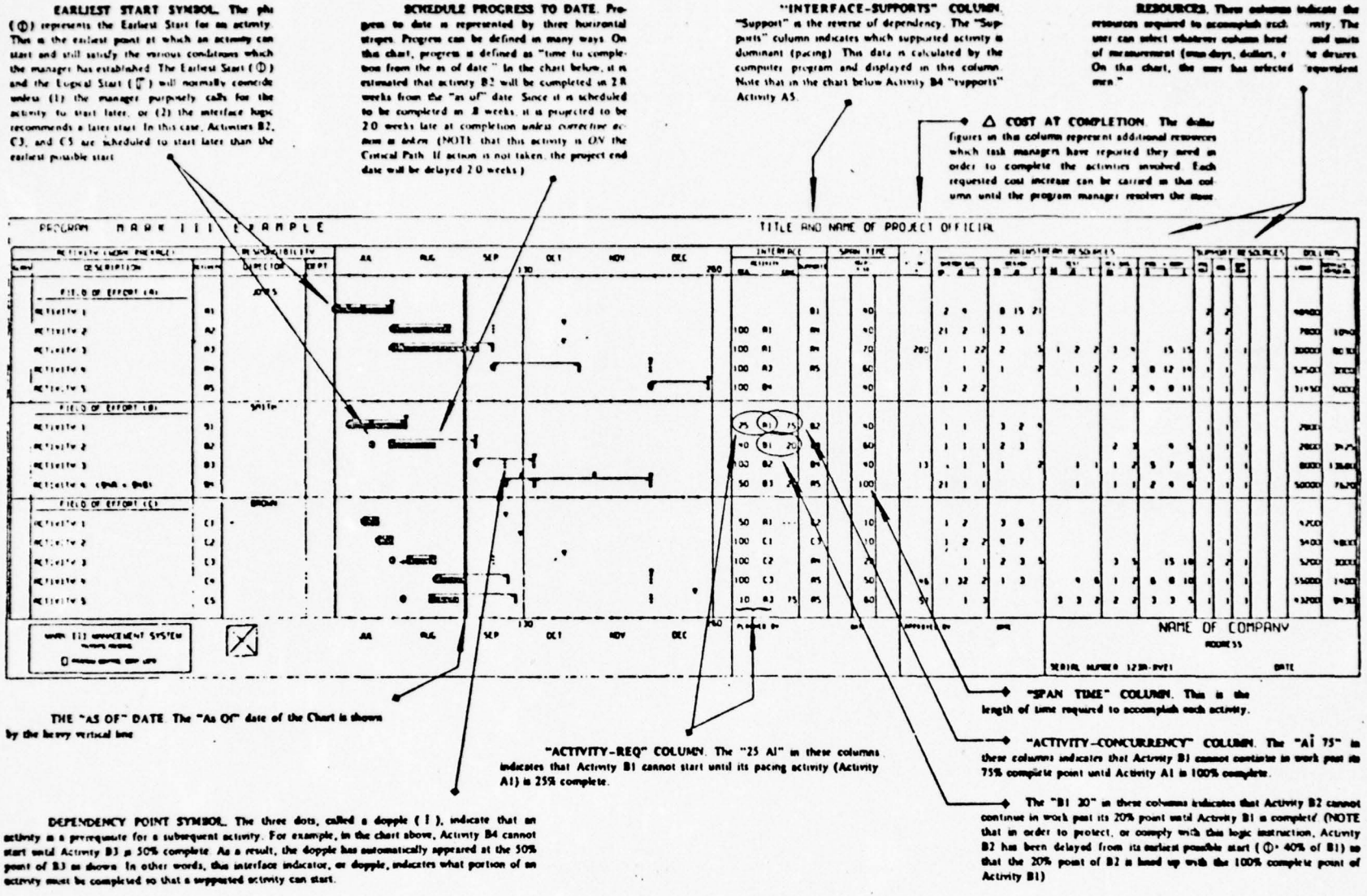

EARLIEST START SYMBOL. The phi (Φ) represents the Earliest Start for an activity. This is the earliest point at which an activity can start and still satisfy the various conditions which the manager has established. The Earliest Start (Φ) and the Logical Start (▽) will normally coincide unless (1) the manager purposely calls for the activity to start later, or (2) the interface logic recommends a later start. In this case, Activities B2, C3, and C5 are scheduled to start later than the earliest possible start.
SCHEDULE PROGRESS TO DATE. Progress to date is represented by three horizontal stripes. Progress can be defined in many ways. On this chart, progress is defined as "time to completion from the as of date." In the chart below, it is estimated that activity B2 will be completed in 28 weeks from the "as of" date. Since it is scheduled to be completed in 8 weeks, it is projected to be 20 weeks late at completion unless corrective action is taken. (NOTE that this activity is ON the Critical Path. If action is not taken, the project end date will be delayed 20 weeks.)
"INTERFACE-SUPPORTS" COLUMN. "Support" is the reverse of dependency. The "Supports" column indicates which supported activity is dominant (pacing). This data is calculated by the computer program and displayed in this column. Note that in the chart below Activity B4 "supports" Activity A5.
RESOURCES. These columns indicate the resources required to accomplish each activity. The user can select whatever column head and units of measurement (man-days, dollars, etc.) he desires. On this chart, the user has selected man.
△ COST AT COMPLETION. The dollar figures in this column represent additional resources which task managers have reported they need in order to complete the activities involved. Each requested cost increase can be carried in this column until the program manager resolves the issue.
PROGRAM MARK III EXAMPLE
TITLE AND NAME OF PROJECT OFFICER
NAME OF COMPANY
THE "AS OF" DATE. The "As Of" date of the Chart is shown by the heavy vertical line.
"ACTIVITY-REQ" COLUMN. The "25 A1" in these columns indicates that Activity B1 cannot start until its pacing activity (Activity A1) is 25% complete.
"SPAN TIME" COLUMN. This is the length of time required to accomplish each activity.
"ACTIVITY-CONCURRENCY" COLUMN. The "A1 75" in these columns indicates that Activity B1 cannot continue in work past its 75% complete point until Activity A1 is 100% complete.
The "B1 20" in these columns indicates that Activity B2 cannot continue in work past its 20% point until Activity B1 is complete. (NOTE that in order to protect, or comply with this logic instruction, Activity B2 has been delayed from its earliest possible start (Φ = 40% of B1) so that the 20% point of B2 is lined up with the 100% complete point of Activity B1.)
DEPENDENCY POINT SYMBOL. The three dots, called a dopple ( ⋮ ), indicate that an activity is a prerequisite for a subsequent activity. For example, in the chart above, Activity B4 cannot start until Activity B3 is 50% complete. As a result, the dopple has automatically appeared at the 50% point of B3 as shown. In other words, this interface indicator, or dopple, indicates what portion of an activity must be completed so that a supported activity can start.

Fig. IV-1c

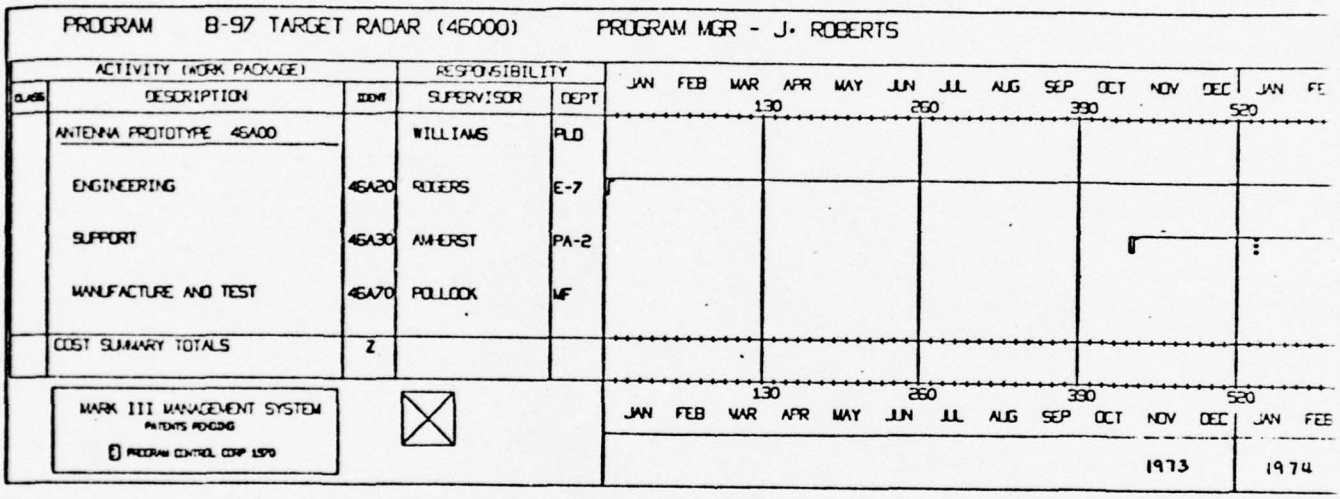

PROGRAM B-97 TARGET RADAR (46000) PROGRAM MGR - J. ROBERTS
ACTIVITY (WORK PACKAGE)
CLASS
DESCRIPTION
ITEM
RESPONSIBILITY
SUPERVISOR
DEPT
ANTENNA PROTOTYPE 46A00
WILLIAMS
PLD
ENGINEERING
46A20
ROGERS
E-7
SUPPORT
46A30
AMHERST
PA-2
MANUFACTURE AND TEST
46A70
POLLOCK
MF
COST SUMMARY TOTALS
Z
MARK III MANAGEMENT SYSTEM
PATENTS PENDING
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FE
130
260
390
520
1973
1974

Fig. IV-2a

Chart Continued from Previous Page.

To achieve Proper Effect, Line Up

Both Segments.

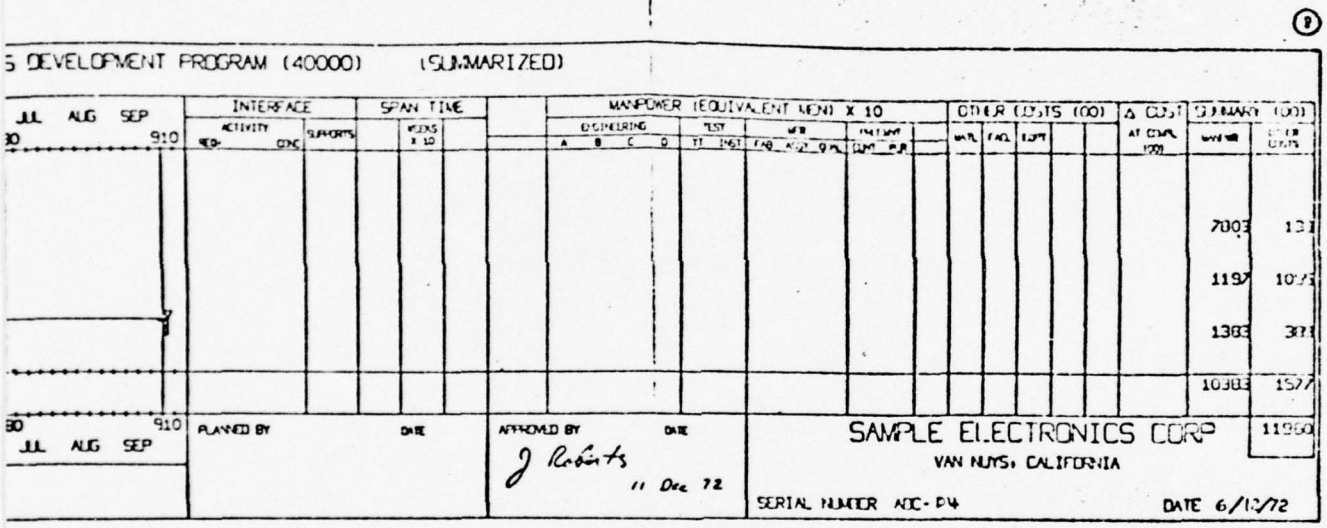



Fig. IV-2b

PROPULSION CATEGORY ESTIMATE (MOTOR) AVERAGE RATE OF LIFE CYCLE COSTS
WEEKLY AVERAGE EXPENDITURE RATE TOTALS FOR ACQUISITION AND SUPPORT
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
PRELIMINARY DESIGN REVIEW
CRITICAL DESIGN REVIEW
INITIAL OPERATIONAL CAPABILITY
SYSTEM TURNOVER
TRW SYSTEMS GROUP
REDONDO BEACH, CALIF.

Fig. IV-3a

PROPULSION CATEGORY (SINGLE MISSION) LIFE CYCLE COSTS
R-D/ACQUISITION COSTS, BASELINE COSTS, C-TOTAL COSTS IN MILLIONS OF DOLLARS
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
PRELIMINARY DESIGN REVIEW
CRITICAL DESIGN REVIEW
INITIAL OPERATIONAL CAPABILITY
SYSTEM LAUNCHER
1500.0
1000.0
500.0
0.0
DOLLARS (IN MILLIONS) CUMULATIVE COSTS
TRW SYSTEMS GROUP

Fig. IV-3b

Figures IV-3a and IV-3b respectively. The histogram can be used to see peaks in a resource utilization and the cumulative curve can be used to show the comparisons between actual costs, planned costs, and earned value.

The preceding list of outputs is not all-inclusive. There are other possible combinations of information that can be provided by the Mark III, depending on the desires of its user. (21:17)

Another service provided by the Mark III that can be very useful to the program manager is the ability of simulating alternatives and answering the "What if...?" questions. If a program manager is faced with several widely different alternative solutions to a serious problem, he can run the alternatives through the Mark III and see what effect each alternative will have on the project as well as the impact on available resources.

The information base for each program can be updated as often as desired. The update procedure, basically, is to collect updated status on current activities as well as many changes that might have occurred in the basic plan (new activities or changed interfaces). This information is then entered by changing the necessary cards in the input deck (only cards involved in update need to be changed) and running them through the computer. Then, a complete set of desired output is received reflecting all the changes. The entire operation can be completed within a day for a normal program. The recommended update times for activity update would depend on the nature and complexity of the program and could

range from daily to quarterly. One month appears to be the normal update period in a SPO.

The principle advantages of the Mark III are that it gives the program manager the flexibility he needs to continually update his plans as well as gives him a complete picture of the status of his program. The Mark III also readily provides information for higher level planning and management in a simple, timely and efficient manner.

Contracts

The Mark III is available to users under three different contract options; lease, full service, and service center.

1. Lease: For a lease price based on the scope of application, a complete Mark III system can be leased to include proprietary computer decks and tapes and a comprehensive User's Manual. Installation of the Mark III on the customer's computer/plotter equipment and training of customer personnel will be accomplished by PCC senior associates. Senior associates can also be provided for additional periods of time to assist in (a) integrating the Mark III with existing management systems, and (b) planning some representative programs using Mark III for the first time. (21:16)

2. Full Service Contract: On a cost plus fee basis, PCC will locate a team of its employees at a customer's facility to handle the operational aspects of a Mark III application. This team can either use the customer's computer/plotter equipment or can use equipment available at a local data processing center. This option is currently on contract at WPAFB for

several acquisition programs. (21:16)

3. Service Center: Service is also provided to customers who do not have computer/plotter equipment and who do not have sufficient volume to justify a full service contract or lease. In these cases the customer provides his input data to a PCC office. PCC processes the data, takes it to a Mark III center, obtains the desired outputs, and sends the resultant charts and graphs to the customer by message service. The price for this service includes the cost of time actually spent in providing service, cost of computer and plotter time, and a Mark III usage fee. (21:16)

## SECTION V

## BENEFITS OF THE MARK III

This section discusses what the Mark III could provide as a management tool if it were implemented AF-wide for acquisition programs. The section will also address some implications of Mark III application.

### Implementation of the Mark III

Integrated Logistics Support Office (ILSO) - The LM would be the primary user of the Mark III and would benefit most from the use of the system. First in the planning phase, the Mark III provides a means for defining all the activities and interfaces involved in completing the project. It allows the project manager to go through an interaction process of changing his plans, redefining activities and adjusting interfaces, so that he can make time schedules and stay within available resources throughout the life cycle of the program. Also, the critical activities are highlighted enabling him to monitor their progress more closely.

As the program evolves through the acquisition cycle, the manager continually has a pictorial representation of progress in the detailed activity chart or in a summary activity chart. For example, in the B-1 program, which has several hundred activities, the LM receives a summary activity chart which summarizes the activities into less than 100

activities. If he desires more information about a particular activity or field of effort, he looks at the detailed activity chart.

From initial planning to completion, the LM can receive the resource graphs in many forms. He can receive just an overall comparison of actual versus planned dollars, or he can receive detailed resource utilization and comparison plots for the three types of resources (manpower, finance, material) for each subgroup. The information that is provided to the LM is selected by him so he only receives what he can use, but it is all available if desired.

The Mark III provides an excellent information base for the LM to draw from to meet reporting requirements to higher management levels in the organization. Commonly used is a summary plot showing just the major fields of effort and an overall resource plot showing actual and planned dollars.

System Program Office (SPO)

The primary use of the Mark III in the SPO would be to monitor the status of integrated logistics support activities on projects within the SPO and to provide information for overall resource planning and utilization. The PM can receive a summary chart and an overall resource graph for each project related to his program. He can retrieve such information as how a manpower change in the SPO or attached organization will impact the ongoing and planned projects. Also, by knowing what the expected resource requirements will be in the future, he can plan his manpower, material and service levels accordingly. Additionally, he can send

information to a higher level concerning the status of all of his projects in the form of summary charts and resource graphs, as required.

The SPO would have a full range of advantages resulting from standardization through the Mark III output. The direction and control within each department would be simplified through the standard flow of project information. With wide expansion of the Mark III, all interdepartmental coordination required for projects which span across departmental lines would be simplified and improved. Through the use of "selective sorts," the PM could receive summary information concerning the status of work going on within the SPO on projects which are being managed externally.

Headquarters Staff Level (Hq AFLC, AFSC, USAF)

The Mark III provides a nearly complete data base concerning current as well as planned projects. This data base can be assessed when desired and provide desired information to the top management in a variety of modes. Reports could be received on a regular basis or only when desired on an ad hoc basis. The ad hoc capability cannot be over-emphasized. The need for the headquarters staff to know precise information concerning a particular project is not frequent, but is very important when it occurs. Rather than answering an inquiry by the headquarters staff or top management from memory, the LM or PM can provide detailed, accurate data from the Mark III as varification data.

The standardization of information format and flow at top management at headquarters level is crucial, due to the critical amount of the time available for information review. The straight forward

summaries of project status and resource utilization derived from the Mark III could provide top management the decision tool needed at headquarters level.

Many of the current reports which are generated at the SPO lend themselves to retrieving information from a common data base and can draw their information directly from the Mark III system.

A significant result of expanded application of the Mark III would be the standardization of education concerning program management. As previously outlined, this would manifest itself in allowing greater flexibility for moving personnel between SPOs. This would further illiminate the need for learning the various reporting formats associated with different programs.

External Reports

The Mark III summary charts and resource graphs provides an excellent means of providing information to the various program sponsors or "using commands" (Hq SAC, TAC, ATC, etc.). If a sponsor desires a status report on his program, the information can be accessed and the Mark III report sent to him without delay. This avoids sending out data or irrelevant information to the user. With the Mark III, current program status is always available if needed for such things as special inquiries from outside agencies. This quick and accurate response would also give the SPO credibility usually resulting in greater external support.

## Implications of Mark III Application

This section contains a summary examination of the resource and human factors involved with implementing the Mark III management system in a program office.

In addition, is a brief discussion of factors involved in a decision to expand the Mark III System.

1. Resource Factors

a. Personnel

In the beginning, considerable time is required at the project level to plan a project using the Mark III. However, it should be noted that the time required should not greatly exceed that which would be required in the use of any other comprehensive planning system, such as PERT. Moreover, any additional time invested initially by SPO personnel should be more than compensated for when considering the overal management effectiveness of the Mark III, the benefits of data automation, and the anticipated reduction in the preparation of specific information for use by higher management. While the use of the Mark III would involve an increase in the workload of the PM now using far less formalized management, much of the information needed for Mark III inputs is being developed routinely in the current management of programs. Admittedly, this information may exist in somewhat different forms.

At management levels above the project level, extensive analysts effort would be required in the transition from manually processed information to a standardized and automated information base. This would

involve a large and time consuming effort. Not only would analysts be required to maintain the flow of essential information, utilizing present methods during the transition period, but likewise, would become heavily involved in the development of standards. These standards are necessary to ensure that the information to be developed within the framework of the expanded Mark III management system facilitates management at all levels to the greatest possible degree. Following these steps, analyst effort would be required to restructure and streamline existing reports to effectively utilize the information which would be provided throught the automated data base. Over the long range, following expansion of the Mark III, analysts working within the management sphere should become more available than they are at present to address those areas in which they can make their unique contribution.

b. Computer

It is anticipated that expansion of the Mark III system would have minimal impact in the Wright-Patterson AFB (ASD) computer area. While this study of the computer operation at WPAFB (ASD) was limited to basic requirements, the possibility of an expanded Mark III role appears to be within the present computer's capacity. Expansion of the Mark III, would still require close scheduling and coordination of its data inputs to the computer.

Discussion with personnel who currently utilize the Mark III in the ILSOs have revealed praise for the contract vendor support which provides much of the technical expertise associated with the Mark III system. Nevertheless, these knowledgeable project personnel have the opinion

that there would be considerable merit in establishing a small group of analysts and programmers (within the existing AF computer organization) who would dedicate their efforts to the application and operation of the Mark III system, and be available to assist SPO personnel with day-to-day computer related technical problems.

c. PCC Contract

As alluded to in the previous paragraph, the Air Force presently has a contract with the Program Control Corporation (PCC) to provide the Mark III computer program and related technical services. In the area of technical services, PCC representatives usually assist the IM with the installation of projects in the Mark III system. A surface review of the existing contract relationship between the AF and PCC indicates that the present arrangements would be adequate as a base for expanding the Mark III system. Again, in expanding the Mark III, priorities would have to be established to utilize contractor support to the best advantage.

d. Education and Training

Successful application of the Mark III system would be a direct function of the ease and familiarity with which it is used. In complete understanding of the computer system's capability and limitations could lead to considerable opposition to its adoption. Resistance to change will be addressed in a subsequent subsection of this study; however, education and training are among the most effective measures for reducing this resistance. Therefore, education and training must be directed to the receptive as well as the reluctant potential user.

One of the advantages of the Mark III system is the core of personnel already available at WPAFB who are knowledgeable in the basic system. If these personnel were utilized in the training effort which would precede expanded Mark III implementation, they would require indoctrination in the various additional features of the system which would be peculiar to the Mark III. Equally worthy of consideration in the development of an education and training plan would be the fact that the use of the Mark III experienced personnel would result in an impact on the regular work performed by these personnel.

The organization of a Mark III training effort would provide a number of possible alternatives. In order to obtain the necessary effectiveness with the smallest number of personnel, several integrated steps would appear to provide an approach to the education and training effort. A logical initial step would be to publish a training manual which would include various standards and operating procedures required for the expanded system. The next step would be to utilize available PCC personnel along with a small group of the most knowledgeable and experienced AF personnel to train upper management and project analyst personnel. Following this, the AF might elect to constitute several Mark III management teams to begin working with SPO personnel to install their program on the system. Vertually all technical and project personnel should receive instruction on the Mark III and its expanded application. The general level of instruction could possibly be accomplished in a half-day concentrated course. Courses of direction up to two or three days might be appropriate for personnel intimately involved with the management

details of projects.

Conversations with PCC personnel revealed that the Mark III is being utilized by commercial sources, but the AF and Navy are the only activities which currently employ PCC technical services on a full time basis. If the expansion of the Mark III were to be accomplished, it would seem to be a worthwhile long-term goal to develop permanent Mark III expertise within the AF, not only would this be important in light of the scope of potential Mark III use, but significant financial savings would occur if the PCC contract were ultimately reduced to the rental of the Mark III program only.

Once the bulk of Mark III education and training were completed, the relatively small residual task of *indoctrinating personnel new to the SPO* would remain, and this task should be an assigned responsibility of some section of a headquarters staff organization.

Human Factors

No matter how desirable change appears to be from a top management viewpoint, it can result in quite a different reaction from the personnel involved. The purpose of this section of the study is to present some of the possible human considerations which would be involved in changes of the scope of an expanded Mark III system.

a. Apprehension

As has been discussed earlier, the Mark III Management System is relatively new at WPAFB. Conversations with SPO personnel detected a

certain amount of potential dislike for the system on the part of personnel who were generally nonusers. Most of the comments of concern received could be divided into two categories. There are those individuals who are concerned over the use of any extensive management method regardless of which was selected, and there are those who have expressed concern over features which they feel are objectionable in primarily the Mark III system.

The first category of personnel feel constrained and committed by the use of any management system which has potential of providing upper management with additional detail and better visibility concerning project work. Further, these same personnel frequently seem to feel that any extensive management system would result ultimately in more upper management control of effort at lower levels. Additionally, project personnel utilizing minimal formal management methods note with concern the added workload any comprehensive system would entail; these individuals find it difficult to visualize the advantages which should accrue from better overall management.

Comments received which pertain only to the Mark III system are on its graphical complexity and the fact that some personnel feel that it would be difficult to make changes with the Mark III since it is computerized. To the untrained observer, the vast amount of information which can be displayed on the Mark III graphical plot is overwhelming. To the trained user, the plot would appear no more complicated than the PERT or CPM display. Also, as previously emphasized, the Mark III displays can be presented in simplified graphical forms. Making changes within the Mark

III could involve from one to a number of computer cards depending on the scope of the change. Without a doubt this is more involved than changing a few lines on a chart, however, the computer automatically accomplishes the realignment of affected activities throughout the project.

b. Resistance to Change

The natural tendancy to resist change from established procedure must be considered when contemplating the expanded employment of the Mark III. Loss of expertise in present methods could be expected to lead to fear of status reduction. The manager who has mastered the intracies of one management system, such as PERT or Gantt, and has used it for a long period of time, is reluctant to leave the comfort of working with a familiar system for a new method, no matter how superior it is supposed to be. Change frequently not only involves loss of expertise but also places a learning challenge on personnel, and it taxes their flexibility. Additional workloads frequently result, because some parallel operation of old and new procedures takes place during the period of transistion.

Whenever management initiaties major change, a substantial increase in direction can normally be anticipated. This increase in direction can be expected to affect interpersonnal relations which in turn, may lead to resistance. (19:246) These interpersonal aspects include not only what relations will occur, but what the personnel involved think will occur. Regardless of the merit of change, how personnel feel about it is the key point. For instance, the problem is as much whether personnel feel that their established relationship within the organization will change, as

whether the relationship will actually change.

c. Considerations in Overcoming Misconceptions and Resistance to Change.

Management must plan and carry out a vigorous program to overcome misconceptions and resistance when major changes are initiated. Foremost in overcoming resistance to change is the demonstration of interest and support by top management or high headquarters. As previously discussed, a comprehensive education and training program is important in ensuring that misconceptions are eliminated and that all potential users are familiar with the new procedure, its capabilities, and the requirements for its successful operation. Inherent in this is a "selling" program to show individuals at each level how the proposed change will benefit them.

Announced or rumored change with little subsequent information on the status or progress of change is disconcerting to the personnel who will be involved. Even during the planning phases of contemplated change, personnel should be kept informed to the maximum extent possible. Every effort should be made to make the planning as participative as possible. Not only does this ensure the inclusion of worthwhile ideas, but it ensures that solutions to potential problems are considered before personnel actually become involved. During this period, personnel frequently preview the feelings that they may be expected to demonstrate during the actual implementation of change. This provides the opportunity for the manager not only to consider the reasons for resistance, but at the same time, to measure its intensity.

During the implementation period, higher management must recognize that its personnel are carrying an additional burden, therefore, must avoid any tendency to view changes to program plans as reflecting negatively on planners. If such a situation were to develop, personnel resistance would grow and the personnel might be tempted to plan pessimistically with attendant wide margins to cover the change of error. Further, under such stress, personnel might resort to subterfuge to cover up their inexperience with the new system. (18: 382-384)

Expanding Mark III Application

From a management viewpoint, implementation of the Mark III as a management tool for interfacing ILS would offer a number of advantages that appear to outweigh the disadvantages. It must be recognized, however, that changes leading to improvements in program management may only be brought about through tradeoffs. These tradeoffs should be accomplished on a most cost effective basis considering the human relation implications involved. For example, in the situation where computerization and standardization is directed by higher headquarters the achieved results may be at the expense of the PMs prerogative to choose the management system of his choice. This condition could be expected to bring about the usual "resistance to change" that managers in all walks of life have encounted for years.

Regardless of the advantage which would be expected to result from a major change in the management of a complex organization, no decision should be made to implement such a change without full recogniztion of

the extent and force of resistance. Neither should a plan for implementation of a change be considered complete without provisions for dealing with resistance through proper organization, education, and communication of the benefits and advantages of the change.

This study addresses the majority of areas that should be considered in a feasibility study with the possible exception of a detailed cost analysis. Expanded application of the Mark III system would involve little or no additional software costs since the Mark III program is currently being used at WPAFB. Although there is a core of personnel already available at WPAFB who are knowledgeable in the basic Mark III system, there would still be costs involved in using these people for education and training programs and other activities associated with the change.

Finally, it is estimated that automation of project planning and reporting formats would save many manhours presently being spent on manual management systems and reports. Estimation of these costs is beyond the scope of this study, but it seems logical that the savings would be substantial. It is also noteworthy that the input data for the Mark III is essentially the same as that prepared for program planning and management, regardless of the system used. One exception is during the conceptual phase where the program is not definitive and it may be more cost effective to maintain the manual technique currently employed for the Integrated Logistics Support Planning until the start of validation phase.

SECTION VI

## IMPLEMENTING THE MARK III ON THE B-1/F16

There are several methods of implementing a computerized management system to be used as a primary management tool for decision making and tracking scheduled activities. Two of these methods will be discussed in this section as experienced on the B-1 and F-16 acquisition programs.

### B-1 Programs:

Implementation of the Mark III system for the B-1 was accomplished in parallel with an effort by Hq AFLC to redefine the logistics support concept for the B-1 aircraft. A working group was formed to develop the logistics support concept and ILS plan. Since participants in each of the functional areas involved in this effort were the same individuals responsible for completing logistics support tasks for the B-1 it was decided that this same working group be responsible for implementing the Mark III system. The working group was composed of individuals from the strategic Air Command (user), Air Training Command (Training), Air Force Systems Command (SPO), Air Force Logistics Command (group chairman, Air Logistics Centers), and Hq USAF (Top management).

When the Mark III was initially introducted by the chairman of the working group, the immediate response was that it was complicated, too detailed, it can't be done, its unmanageable, etc. A senior Program

Control Corporation (PCC) representative then gave a presentation on the content explaining each symbol and use of the system. This still did not convince the group that it was a good management tool. The meeting was adjourned until the next morning and each group member was to take the computer outputs with them overnight to identify tasks related to their area of responsibility. That evening individuals cognizant of the Mark III were available to answer questions and clarify any misconceptions. The next morning the individuals mostly against the system initially became some of the stronger advocates of the system. A formal reporting form (Figure VI-1) was distributed to the group with a majority disapproval. After consultation between the group chairman and the PCC representative it was decided that each participant could utilize the format of his choice as long as it contained the following criteria: (a) activity or tasks to be accomplished; (b) activity span times, (c) the interdependencies between activities (what activity interrelates with another), and (d) resource estimates. Resource estimates were delayed until all other criteria were complete. This approach was acceptable to the group. A subgroup chairman was selected from within the working group for each functional area addressing Integrated Logistics Support activities. Two iterations later the Mark III detailed activity output was developed into a usable management tool.

Some key points to address concerning this process are the importance of communications between people, dealing with resistance to change, coordination between subgroup chairman, interchange of ideas, resolution of conflict, and acceptance of responsibility. The collective interaction

PROG ____ SP ____

MARK III

# 1/3 CARD COMPOSITE -ABBREVIATED-

| ACTIVITY NO | DESCRIPTION OF ACTIVITY | ACTIVITY SPAN TIME -UNITS- | REQUIRED INTERFACE: PCT OF ACT TO BE | REQUIRED ACTIVITY | PCT THIS ACT-COMP | SCHEDULE ORDER IN START | CALENDAR START DATE | REMARKS |
|---|---|---|---|---|---|---|---|---|
| | MOTOR | | | | | | | UNDERLINE |
| MT02 | ESTABLISH PERFORMANCE RQMTS | 050 | | | | | 16 JUL 73 | ✓ |
| MT04 | REVIEW EXISTING SPECIF/S | 150 | 100 | MT02 | | | | ✓ |
| MT06 | SELECT PRODUCTION MTR CONFIG/S | 050 | 100 | MT04 | | | | ✓ |
| MT08 | PREPARE+DISTRIBUTE RFQ | 400 | 100 | MT06 | | | | ✓ |
| MT10 | REVIEW RESPONSES | 200 | 100 | MT08 | | | | ✓ |
| MT12 | AWARD CONTRACT | 050 | 100 | MT10 | | | | ✓ |
| MT14 | FAB+DLVR PROD MOTORS | 1200 | 100 | MT12 | | | | AF20 |
| | | | | | | | | |
| | | | | | | | | |
| | AIRFRAME | | | | | | | UNDERLINE |
| AF02 | RVW+SELECT AIRFRAME DESIGN | 300 | | | | | 01 JUL 73 | ✓ |
| AF04 | REDESIGN AIRFRAME AS RQRD | 400 | 100 | AF02 | | | | ✓ |
| AF06 | DWG PROOF REDESIGNED CONFIG | 200 | 75 | AF04 | *** | | | ✓ |
| AF08 | DESIGN REVIEW (AIRFRAME) | 050 | 100 | AF06 | | | | ✓ |
| AF10 | PREP PROCUREMENT PACKAGE | 200 | --- | AF06 | 75 | | | ✓ ALSO 100% AF02 |
| AF12 | PREP + DISTRIBUTE RFQ | 300 | 100 | AF10 | | | | ✓ ALSO 100% AF08 |
| AF14 | REVIEW RESPONSES | 200 | 100 | AF12 | | | | ✓ |
| AF16 | AWARD CONTRACT | 050 | 100 | AF14 | | | | ✓ |
| AF18 | FAB+DLVR AIRFRAME UNITS | 1200 | 100 | AF16 | | | | ✓ |
| AF20 | INTEGRATE FOR CAPTIVE FLIGHT | 300 | 100 | AF18 | | | | END |
| AF20 | | 300 | 100 | MT14 | | | | |
| AF20 | | 300 | 100 | GC06 | | | | |
| AF20 | | 300 | 100 | FZ12 | | | | |
| | | | | | | | | |
| | G + C | | | | | | | UNDERLINE |
| GC02 | PROCURE MK 91 GUID+CONTRL SETS | 1200 | | | | | 22 AUG 73 | ✓ |
| GC04 | MODIFY+TEST G+C ASSYS | 800 | 50 | GC02 | *** | | | ✓ |
| GC06 | PKG FOR AIRFRAME INSTAL | 600 | 25 | GC04 | *** | | | AF20 |
| | | | | | | | | |
| | | | | | | | | |
| | FUZE | | | | | | | UNDERLINE |
| FZ02 | VALUE ENGINEER MK99 FUZE | 400 | | | | | 01 AUG 73 | ✓ |
| FZ04 | PREP VE DWG REVISIONS | 300 | 75 | FZ02 | *** | | | ✓ |
| FZ06 | FAB, TEST + VERIFY VE/D DSGN | 400 | 100 | FZ04 | | | | ✓ |
| FZ08 | COMPLETE DWG PACKAGE | 200 | 75 | FZ06 | *** | | | ✓ |
| FZ10 | DESIGN REVIEW (FUZE) | 050 | 100 | FZ08 | | | | ✓ |
| FZ12 | PROCURE VE UNITS-USING QPL | 1200 | 100 | FZ10 | | | | AF20 |

PCC FORM APL-1/3 ABBREV (18 JAN 1974)

Fig. VI-1

of all of these conflicts are common to both group behavior and individual behavior yet they seemed to diminish through group influence.

Other aspects of the B-1 Mark III system are; (a) all activities are tied or interfaced to major milestones of the total program, (b) the LM is the integrator of the Mark III but the PM still has overall responsibility for completion of tasks, (c) an informal reporting system has been established whereby reporting/updating is accomplished at least monthly by telephone not requiring paper flow, (d) summary activity charts are being sent to Hq AFLC for higher management reporting, and (e) functional personnel with task responsibility now have a complete knowledge of how their area of responsibility interfaces with other areas of the B-1 system and are enthusiastically contributing to the efficient flow of management information to the ILSO.

The last important point to be emphasized is that all active participants of this newly developed management information system have a common baseline since they established the logistics support concept, therefore, are assuming an ownership role in driving toward the success of task completion. (14)

F-16 Program:

Implementation of the Mark III system on the F-16 program was initially composed of a one-to-one relationship between the responsible individual in the ILS office and each functional activity point of contact. After all functional areas were individually and independently identified and contacted, a group meeting was held to review and

restructure the individual tasks into an integrated logistics support network.

This approach was taken in lieu of the working group method used for the B-1 primarily due to the lack of travel funds and dedicated personnel. As a result there was apprehension in proceding with the one-on-one approach with the fear that task integration would be too complex to formulate a reliable plan.

The deputy IM was assigned the responsibility for implementing the Mark III on the F-16 program with the assistance of a PCC representative. The Integrated Logistics Support elements as contained in DoDD 4100.35 were individually broken down into activity interfaces including related high cost/high risk activities. Responsible individuals were identified for each of these areas and were tasked to submit their respective plans and associated interfaces. Each individual was personally interviewed by the deputy IM and the PCC representative to establish rapport, program objectives, areas of responsibility and reporting requirements.

After each area was structured and assembled into the Mark III computerized format the deputy IM chaired a meeting with all functional participants in attendance. The network was reviewed by task, identifying areas of responsibility and conflict. Problem areas were resolved resulting in the formulation of a truly integrated Logistics Support Plan. Resource inputs will be initiated in late 1976.

The resistance to change seemed less than that experienced during the implementation period for the B-1 program. However, this could be

due to the different personalities involved in the individual programs.

Some of the advantages of the one-on-one approach is that it is cheaper, takes less manpower resources, and involves less conflict.

There are some disadvantages however, in that the one-on-one approach takes longer to complete the total integrated network and lacks initial group pressures to facilitate planning and schedule control.

Both approaches discussed in this paper were successfully implemented though it should be noted that both involved intimate group interaction to resolve areas of conflict even though their initial approaches differened. (15)

## SECTION VII

## CONCLUSIONS/RECOMMENDATIONS

Coping with and managing the dynamic complex weapon systems of today requires "real time" information. Top DoDD and military leaders recognize this need, though the proper motivative vehicle for implementing the required management tools have not materialized. As a result some of the current major weapon systems are being managed using manual techniques which are ineffective and contain obsolete information. Considering the excessive costs for developing and supporting new weapon systems the allowance for management error due to insufficient data is becoming unacceptable. It is time we managers face up to the resistance to change dilema and consider the application of mechanized management tools for the decision-making process. Therefore, I recommend the Air Force implement a planned program for the standardization of Integrated Logistics Support planning through the use of the Mark III management system which meets the criteria established in the objective of this study.

In addition, all related tasks should be interfaced to the work breakdown structure (WBS) defined in Mil-Std-881A which states that "the elements of ILS shall be accommodated as indicated in the summary levels of WBS in appendices A through G." This final link with the program would enable the PM to retain control of the logistics support and would ensure continuity. (17)

Consideration should also be given to expanding the use of the Mark III system to managing the total weapon system throughout the acquisition process after it is proven effective in the ILSO. Because expansion of the Mark III system possibly involves unforseen factors, periodic reviews should be conducted during the planning phase to ensure that additional factors are identified which might alter the basic decision for expansion.

## BIBLIOGRAPHY


1. "AFLC Announces New Staff Organization," AFLC Office of Information News Release, No. 74-26, January 1974.

2. Air Force Pamphlet 800-7, "Integrated Logistics Supported: Implementation Guide for DoD Systems and Equipments."

3. Air Force Systems Command Pamphlet 800-21, A Guide for Program Managers: Implementing Integrated Logistics Support, 18 June 1974.

4. Air Force Systems Command, History of Air Force Systems Command, 1 July 1968 - 30 June 1969, Andrews AFB, Maryland, Air Force Systems Command, Fiscal Year 1969.

5. Air Force Systems Command/AFLC Regulation 400-10, Integrated Logistics Support of System Programs, 16 April 1969.

6. Air Force Regulation 800-8, Integrated Logistics Support (ILS) Program for Systems and Equipment, 27 July 1972.

7. "Decision Making Through Operations Research," Thierauf, R. J. and Gross, R. A., John Wiley, 1970.

8. "Decision Year for A Flying Air Force," Armed Forces Management, Vol. 16, November 1969.

9. Department of Defense Directive 3232.1, DOD Maintenance Engineering Program, November 3, 1955 (cancelled).

10. Department of Defense Directive 4100.35, Development of Integrated Logistic Support for Systems and Equipment, June 19, 1964, (cancelled).

11. Department of Defense Directive 4100.35, Development of Integrated Logistic Support for Systems/Equipment, October 1, 1970.

12. Department of Defense Directive 5000.1, Acquisition of Major Defense Systems, July 13, 1971.

13. Department of Defense 4100.35G, Integrated Logistics Support Planning Guide for DOD Systems and Equipment, October 15, 1968.

14. Hennigan, G. R., Lt Col, ASD/YHL, Telephone Interview Wright-Patterson AFB, Ohio, January 8, 1976.

15. Kavanagh, Jay, Program Control Corporation, (PCC), Telephone Interviews, February 3, 1976.

16. "Mark III Management System Users Manual," Program Control Corporation, 1971.

17. Mil-Std 881A, "Work Breakdown Structures for Defense Material Items," 25 April 1975.

18. Network Based Management Systems (PERT/CPM)," Archibald, R. G., and Villoria, R. L., John Wiley and Sons, Inc. 1967.

19. "Personnel: The Human Problems of Management," Sayles, L. R., and Strauss, G., 3d Edition, Prentice Hall, 1960.

20. Stempson, James A., Lt Col, Hq, AFLC/AQML, Telephone Interview, Wright-Patterson AFB, Ohio, February 26, 1976.

21. "The Next Generation In Project Management: Mark III Program Control Corporation, 1973.