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FINAL REPORT

AIRCRAFT MODIFICATION MANAGEMENT EVALUATION

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Wright-Patterson Air Force Base
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ABSTRACT

This report describes the results of an in-depth survey among Air Force personnel experienced in the aircraft modification management process. The cause-and-effect relationships of problems that they identified were examined, together with those areas which they perceive could benefit from changes. The results were analyzed to establish a hierarchy of key issues and to structure an approach to their resolution.

The work was performed under Contract F33615-80-C-5102, sponsored by the Air Force Business Management Research Center, Wright-Patterson Air Force Base, Dayton, Ohio.

EXECUTIVE SUMMARY

1. BACKGROUND

Because of the long lead times and large budgetary outlays associated with major weapon system acquisitions, it is planned that most of the current inventory of U.S. Air Force aircraft types will remain in service through the 1990s. As a result of this continued use of existing aircraft, the Air Force must pursue an aggressive modernization program to maintain the force structure at a high level of operational readiness. Rapidly expanding technology is being exploited to maintain a high degree of capability in an aging force. These factors are expected to result in an extensive aircraft retrofit program at least through the year 2000. To ensure the smooth implementation of this modification effort for aircraft weapon systems, the Air Force must continue to improve modification management techniques.

Fundamental problem areas exist in current Air Force management techniques for aircraft modification. The most significant of these problem areas are commonly recognized: (1) modification programs are being planned and funded on the basis of simultaneous equipment developments that could easily slip in schedule; (2) some new avionics are being developed without the involvement of appropriate aircraft system managers in areas related to modification planning; and (3) budgeting and programming activities for aircraft modification are not clearly defined and are complicated. It is important that appropriate Air Force managers be made aware of these and other problem areas that could inhibit the effective management of aircraft modification. Therefore, this analysis was undertaken (1) to identify, define, and validate the most significant problem areas in aircraft modification management; (2) to examine the cause-and-effect relationship of identified problems and develop a structured approach to their resolution; and (3) to identify topics requiring research and initiatives leading to improvement in aircraft modification management.

2. SURVEY OF MODIFICATION MANAGEMENT COMMUNITY

2.1 Methodology

Initially, we reviewed the results of recent studies on problems and issues in modification management. We developed a short questionnaire

directed toward resolving open issues for which consensus was not apparent, and then we conducted an in-depth survey.

The survey was accomplished in two forms. First, we mailed a multiple-choice questionnaire to a cross section of 90 organizations of the development, support, and user communities, as well as the Air Staff. Second, we conducted structured interviews with 18 selected senior Air Force civilian (GS-14 and -15) and military (04 through 07) modification managers, using the same questions as in the mailed questionnaire, but in an "open ended" form. The questionnaire consisted of nine questions developed from issues frequently discussed within the modification management community.

2.2 Survey Results

The results of the survey indicated that the Air Force modification managers were aware of many problems with the existing modification management system.

The initial set of questions in the survey was designed to determine the modification management community's opinions concerning the requirements and priority-ranking process. The responses indicated that some of the significant issues were (1) the process is too long, (2) requirements are often poorly defined and change frequently, (3) there is a lack of ranking and modeling tools, and (4) proposed modifications are inappropriately grouped for priority ranking.

The second set of questions was designed to elicit opinions regarding organization and staffing issues in modification management. Most of the responses indicated that the Program Management Responsibility Transfer (PMRT) process is generally lacking in continuity and that a single management authority should oversee development and implementation for modifications. Other comments indicated dissatisfaction with the Air Staff's organization and staffing processes for modifications.

The third group of questions was related to the funding and budgeting process for modifications. Respondents perceived problems in the areas of cost-estimating tools, procurement procedures, funding and budgeting procedures, and long-range planning.

The final group of questions dealt with weapon system integration. The majority of the comments in response to these questions indicated a need for more interface standards, more planning for future integration architecture, and better communications between the subsystem developer and the weapon system manager.

3. ANALYSIS

The first step in the analysis was to define the effect of major problem areas on the current modification process. The problem areas addressed in the study were identified on the basis of our review of the survey results,

as well as other studies and formal guidance. The cause-and-effect relationship of the individual contributing elements to these problems were examined in light of the current modification process. The objectives were to relate problem areas to the current modification process and to provide the basis for developing issues.

A hierarchy of key issues was developed by examining the individual contributing elements that constituted the problem areas. This examination considered all the individual contributing elements as a single group. In this way we organized multiple elements under common headings to create hierarchies of key issues. These key issues were then structured into an activity "road map" depicting a structured approach to their resolution.

4. APPROACHES TO IMPROVING MANAGEMENT PRACTICES

Our analysis determined that the seemingly large number of issues surrounding aircraft modification management could be reduced to relatively few when viewed from a cause-and-effect perspective. We found that there are four primary paths of action leading to improvement management that could be followed in parallel or individually. Some of the required activities support the objectives of more than one path.

We summarized the alternatives represented by the key-issue hierarchies into a "road map" for implementation as depicted in Figure S-1. The overall objective, indicated at the terminus of the map, is to improve the management of modification programs. Numbered goals correspond to the key issues identified during the analysis process. Each path identified by Roman numerals presents the approach suggested by our analysis to reach the overall objective. Each numbered path depicts those activities oriented toward resolving correspondingly numbered goals.

The upper left-hand corner summarizes the existing organizational and policy framework for conducting modification programs. The proposed initiatives are grouped by our perception of how they might contribute to one or more of the following four major paths:

- Path I could be implemented within the current policy framework. It would establish better training in current procedures, identify methods for improving PMRTs, investigate methods for increasing effectiveness of a single-manager concept, promulgate ranking and modeling tools, and group Class IV and Class V modifications to provide comparative evaluation.
- Path II requires an active program of analysis and planning by the Air Force. Some activities in Path II are complementary to Path I, as shown. This path adds, in particular, development of system lifetime plans, together with a requirements baseline, to stabilize requirements for major aircraft weapon systems.
- Path III would require major planning and programming initiatives, to be implemented within DoD guidelines. These activities would

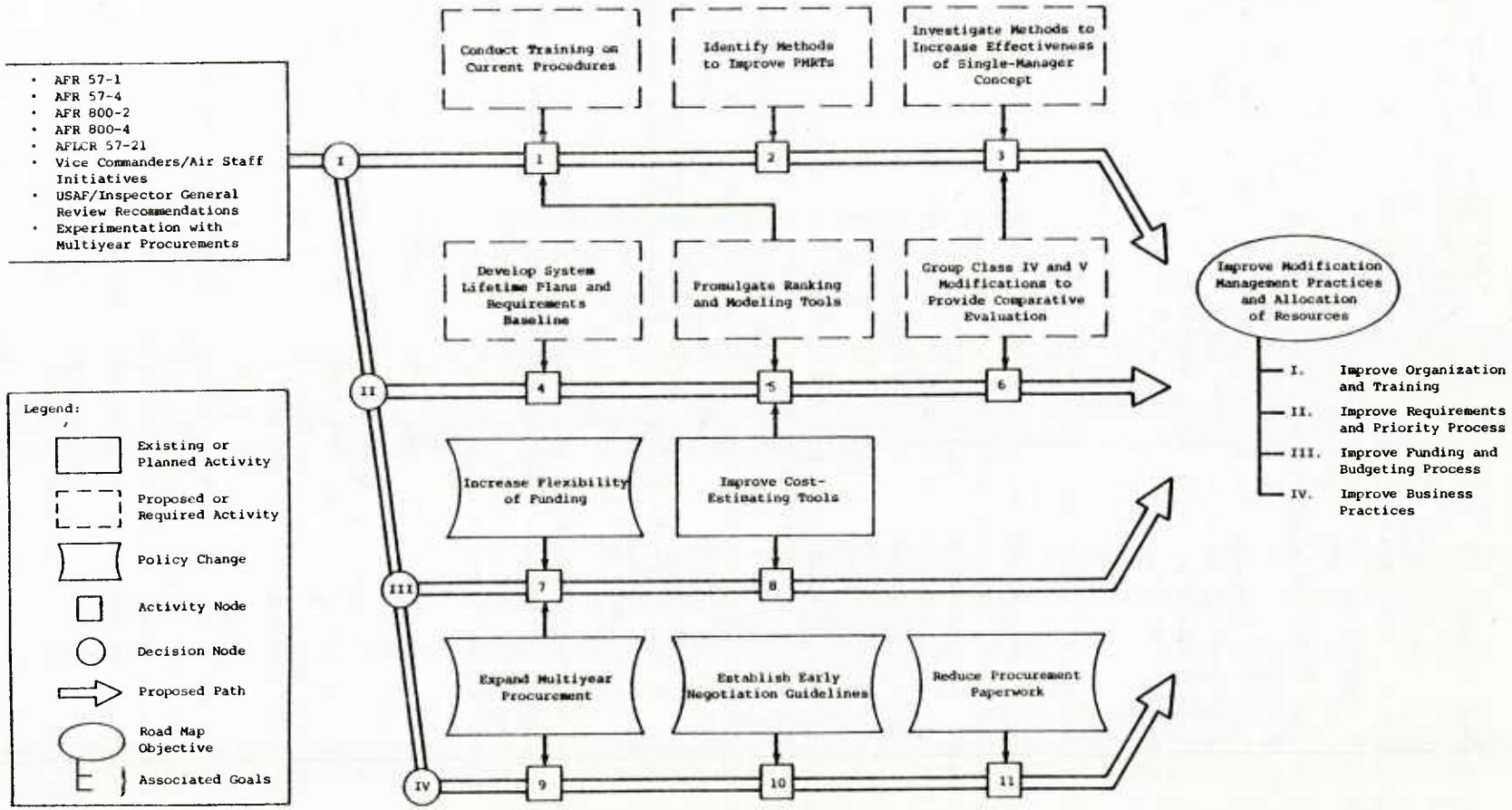

Figure S-1. "ROAD MAP" OF MODIFICATION MANAGEMENT INITIATIVES

be geared to investigating improved procedures and policies to increase the flexibility of funding modification programs and to expand the use of multiyear procurements.

- Path IV requires a combination of Air Force and DoD procurement regulation changes. In particular, methods, guidelines, and policies would be investigated to determine how to accomplish early negotiation efforts and how to reduce procurement paperwork.

The initiatives presented in Figure S-1 could be implemented as a comprehensive program or as separate initiatives, either serially or in parallel. The activities are arranged in logical order, indicating those which serve multiple paths.

5. RECOMMENDATIONS

We recognize that solutions to many of the issues discussed can be quite complex because of institutional preferences, organizational inertia, and availability of resources; therefore, it appears that implementation of the structured "road map" approach requires dedicated sponsorship and determination for successful completion. The steps that are easiest to achieve should be initiated first; those which are more difficult at later dates. In keeping with this general philosophy, ARINC Research recommends that the Business Research Management Center take the following actions:

- Coordinate the results of this study with other current Air Force efforts to improve modification management.
- Discuss initiatives with cognizant Air Force organizations (1) to determine the feasibility of implementing various activities, (2) to designate responsible parties, and (3) to agree on charter areas.
- Selectively undertake or sponsor those activities which are institutionally achievable within current available resources. Plan for implementation of subsequent activities for which agreements can be reached and resources identified.

GLOSSARY

Numerous abbreviations and acronyms are used in this report. They are explained here for the reader's convenience.

AFLC	-	Air Force Logistics Command
AFSC	-	Air Force Systems Command
ALC	-	Air Logistics Center
APDM	-	Amended Program Decision Memo
ASB	-	Air Staff Board
BA	-	Budget Authority
BCI	-	Budgetary Cost Information
BES	-	Budget Estimate Submission
CCB	-	Configuration Control Board
DAC	-	Deputy for Avionics Control
DoD	-	Department of Defense
FSED	-	Full Scale Engineering Development
FY	-	Fiscal Year
MAJCOM	-	Major Air Command
MIP	-	Material Improvement Proposal
MPA	-	Modification Proposal and Analysis
MRG	-	Modification Review Group
O&M	-	Operations and Maintenance
OSD	-	Office of the Secretary of Defense
PA	-	Program Authority
PAD	-	Program Action Directive
PE	-	Program Element
PEM	-	Program Element Monitor
PMD	-	Program Management Directive

PMP	-	Program Management Plan
PMRT	-	Program Management Responsibility Transfer
POM	-	Program Objective Memorandum
PPBS	-	Planning, Programming, Budgeting System
PRC	-	Program Review Committee
PRG	-	Priority Review Group
RDT&E	-	Research, Development, Test & Evaluation
RFP	-	Request for Proposal
RRG	-	Requirements Review Group
R&M	-	Reliability and Maintainability
SE	-	Support Equipment
SM	-	System Manager
SON	-	Statement of Operational Need
SPO	-	System Program Office
TCTO	-	Time Compliance Technical Order

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CHAPTER ONE

INTRODUCTION

1.1 SCOPE

This report was prepared by ARINC Research Corporation for the U.S. Air Force Business Research Management Center under Contract F33615-80-C-5102. It presents the results of a three-month investigation into the Air Force aircraft modification process. The objectives of this effort were to identify key technical and managerial issues as perceived by the Air Force modification management community and to develop approaches to their resolution. A survey of major Air Force organizations was conducted and discussions were held with key individuals involved in aircraft modifications to identify problem areas and issues. Areas requiring research and initiatives leading to improved modification management were identified, and a structured approach to their resolution was prepared.

1.2 BACKGROUND

Because of the long lead times and large budgetary outlays associated with major weapon system acquisitions, it is planned that most of the current inventory of Air Force aircraft types will remain in service through the 1990s. As a result of this continued use of existing aircraft, the Air Force must pursue an aggressive modernization program to maintain the force structure at a high level of operational readiness. Rapidly expanding technology is being exploited to maintain a high degree of capability in an aging force. These factors are expected to result in an extensive aircraft retrofit program at least through the year 2000. To ensure the smooth implementation of this modification effort for aircraft weapon systems, the Air Force must continue to improve modification management techniques.

Scheduling for major retrofits must take into consideration the Air Logistics Center (ALC) workload, modification-kit production schedules, operational availability of aircraft, and the capability profile of the weapon system being modified. Budget issues include long-range coordination of modification and procurement funding to ensure timely availability of resources and the development of a long-term investment strategy for modifications. Technical issues include such areas as Group A and Group B kit design trade-off options, interface methodology, and aircraft power and cooling capacities.

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There are fundamental problem areas in the Air Force management techniques for aircraft modification. The most significant of these are commonly recognized: (1) modification programs are being planned and funded on the basis of simultaneous equipment developments that could easily slip in schedule; (2) some new avionics are being developed without involving appropriate aircraft system managers in areas related to modification planning; and (3) budgeting and programming activities for aircraft modification are not clearly defined and are complicated. It is important that appropriate Air Force managers be made aware of these and other problem areas that could inhibit the effective management of aircraft modification.

1.3 TASK DEFINITION AND APPROACH

The objectives of this effort were (1) to identify, define, and validate the most significant problem areas in aircraft modification management; (2) to examine the causes and effects of identified problems and develop a structured approach to their resolution; and (3) to identify areas requiring research and initiatives leading to improvement in aircraft modification management. The following sections describe the two tasks defined in the Statement of Work.

1.3.1 Task 1: Conduct Preliminary Survey of Aircraft Modification Management

Our initial activity for Task 1 was to conduct a search of current literature, regulations, and directives pertinent to aircraft modification management. The Defense Logistics Studies Information Exchange (DLSIE) and the Air Force Institute of Technology, School of Logistics Management, were the primary literature sources. We also performed a literature search using the Lockheed DIALOG Information Retrieval System. An annotated bibliography of the studies and research projects resulting from our literature search is presented in Appendix A, together with some of the key formal guidance we reviewed.

Our next step was to perform a survey of major Air Force organizations involved in various aspects of aircraft modifications. The survey was in the form of a questionnaire distributed widely to organizations within HQ USAF, AFLC, AFSC, SAC, TAC, MAC, ATC, USAFE, PACAF, ALD, the ALCs, and AFSC Product Divisions. A majority of those surveyed were also participating in a modification study sponsored by AFSC/XR. The questionnaire was developed on the basis of results of our literature search and information from a selected group of ARINC Research technical experts with significant experience in modification management processes. Discussions were conducted with key organizations and individuals responsible for aircraft modifications to establish the current level of understanding of the issues surrounding the programming and management of modification programs. Appendix B contains the mailing distribution list, a listing of personnel interviewed, and survey comments.

In addition, under Task 1, a survey and analysis plan was developed and presented to the Government for approval.

1.3.2 Task 2: Perform Technical Analysis of Aircraft Modification Management Problems

Problem areas identified in Task 1 were categorized as policy, technical, planning, business, requirements, and funding and budgeting. Next, the cause-and-effect relationship of the individual issues within each category were examined, including the influence on the current modification process of changes in "causes." A hierarchical structure of key problems was then developed. Finally, an activity "road map" depicting a structured approach to resolving key issues was developed.

1.4 REPORT ORGANIZATION

Chapter Two presents an overview of the current Class IV and V modification processes. Chapter Three describes the results of the survey of the Air Force modification management community. Chapter Four describes our analysis of aircraft modification management problems. Chapter Five presents a structured approach to resolving key issues, and Chapter Six presents our conclusions and recommendations.

Appendix A lists the references used in the study effort and a bibliography. Appendix B contains the survey distribution list, the personnel interviewed, and survey comments. Appendix C presents the summary briefing of the overall study effort.

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CHAPTER TWO

CURRENT MODIFICATION PROCESS

This chapter presents an overview of the Class IV and V modification processes. It is assumed that the reader has some prior knowledge of Air Force modification management; therefore, the processes addressed here are not described in depth. Instead, the descriptions are designed to provide a frame of reference for the reader's study of the modification-process analyses that are presented in subsequent chapters of this report. The narrative and flow chart descriptions of the modification processes provided in this chapter were taken primarily from the new draft AFR 57-4, which, when published, will replace the current December 1977 version, as amended.

2.1 CLASS V MODIFICATION PROCESS

2.1.1 Assumptions

The Class V modification flow chart shown in Figure 2-1 assumes a modification requiring engineering development only. The accompanying description will be limited to modification in which the development is accomplished by AFSC and the installation is accomplished by AFLC. For the flow of activities, it is assumed that there will be no delays between activities and no delays caused by funding, validation, staffing, engineering, or other problems.

2.1.2 Requirements Validation Process

As shown in Figure 2-1, the Class V modification process begins with the operational requirements process. This first step typically begins when the operating command submits a Statement of Operational Need (SON) in accordance with AFR 57-1. The SON validation process begins with reviews of the requirement by the Air Force Systems Command (AFSC), the Air Force Logistics Command (AFLC), and other Major Air Commands (MAJCOMs). AFSC and AFLC review the SON from their respective positions as developer and implementer and provide comments on possible alternative solutions. The ALC System Manager (SM) for the system to be modified and the AFSC Product Division Project Officer are tasked to provide Budgetary Cost Information (BCI), which identifies preliminary cost and schedule information for the proposed modification. A HQ USAF/RDQ action officer is assigned to staff the requirement and present the SON for possible validation to the

Requirements Review Group (RRG). The SON process, from submission through validation, requires about eight months.

2.1.3 PEM Advocacy During the Planning, Programming, Budgeting System (PPBS) Phase

After validation a Program Element (PE) is established and a Program Element Monitor (PEM) from the responsible Air Staff directorate is assigned as the program advocate. The PEM is responsible for acquiring program funding and directing implementation after funding is received. In his advocate role, the PEM presents his proposed program to both Air Staff Board Panels and the Priority Review Group (PRG), where it competes for engineering development funds and procurement funds, respectively. The panels prepare proposed mission area programs for the current Program Objective Memorandum (POM), and the PRG prepares priority lists of the modifications for AF/XOO approval.* The proposed mission area programs and proposed modification programs are integrated into the POM by the Program Review Committee, which then briefs the POM through the Air Force Board structure for approval. The POM is then submitted to the Office of the Secretary of Defense (OSD) for approval by Amended Program Decision Memo (APDM) after issues are resolved.

2.1.4 Budgeting Phase

The Budget Estimate Submissions (BES) are now prepared on the basis of the APDM. The PRG reviews all new-start Class V modifications in the APDM, and the Modification Review Group (MRG) reviews the final modification budget. This process translates the POM into a current-year President's budget and the next Five-Year Defense Plan. The budget then undergoes the approval and appropriation process. Budgetary submissions follow the DoD budgetary cycle. For the budget phase of the PPBS, initial budgets are submitted in July, and the budget phase culminates in the submission of the President's budget to Congress the following January. Funds are then allocated to programs on the basis of Congressional approval. The combined programming and budgeting cycle requires about 18 months.

It is perhaps appropriate to note here the Congressional restrictions on Class V modification funding. First, separate funding is required for Research, Development, Test and Evaluation (RDT&E) (appropriation 3600),

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*These two processes do not normally occur simultaneously for a given Class V modification. The priorities for new-start Class V modifications are established at budget lead time away from procurement and installation. Budgeting for a Full Scale Engineering Development (FSED) program (which may vary in length from one to five years, or longer) is not necessarily concurrent with its associated modification installation effort. Under present rules, program budgeting must be accomplished for the modification before FSED is approved; however, for long-term development efforts, budgeting for modification installation may be several years beyond the current fiscal year.

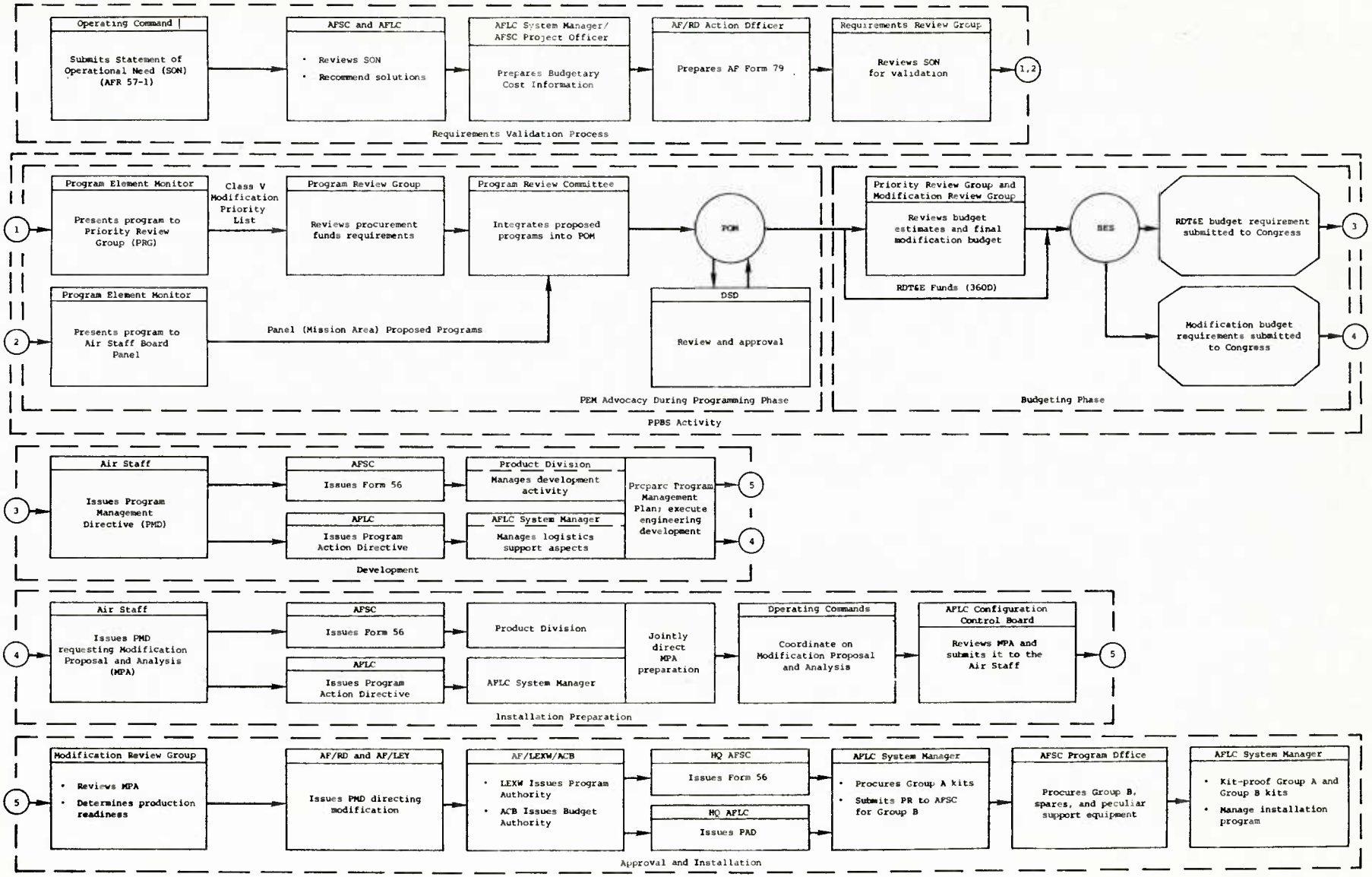

Figure 2-1. FLOW CHART OF CLASS V AIRCRAFT MODIFICATION

production (appropriation 30XX), and operations and maintenance (O&M) expenditures (appropriation 3400). The second restriction, full funding, requires that for each year only those items which can be installed in one year may be procured. Third, the funds for a modification must be budgeted in the year in which the modification is to be accomplished.

2.1.5 Development Phase

The development phase of a Class V modification begins when a Program Management Directive (PMD) is issued by the Air Staff. The PMD provides specific direction for the program, with development responsibility generally assigned to AFSC and responsibility for logistics support aspects assigned to AFLC. AFSC, in turn, issues a Form 56, assigning development responsibility to its pertinent product division. AFLC issues a Program Action Directive (PAD), which assigns management responsibility to the appropriate system manager or item manager at its Air Logistics Centers. Group A and B kits, data, trainer modifications, and support equipment are developed and tested. The time required to complete the FSED phase varies.

2.1.6 Installation Preparation Phase

The installation preparation phase begins when the Air Staff issues a PMD requesting Modification Proposal and Analysis (MPA) documentation. In turn, HQ AFSC issues a Form 56 and AFLC issues a PAD, and both direct MPA preparation. The MPA is usually prepared by the ALC SM, with inputs from the product division responsible for development. Using commands coordinate the MPA, which is then reviewed by the AFLC Configuration Control Board and forwarded to HQ USAF. The MPA process usually takes four months and is accomplished before the development program is completed.

2.1.7 Approval and Installation

The MRG reviews the MPA and the entire development effort to determine if the modification is ready for production. The PMD directing implementation of the modification is prepared and signed out jointly by the RD director and AF/LEY. At this time, Air Staff responsibility transfers from RD to LE and AFLC becomes responsible for implementing the modification.

USAF/LEXW issues Program Authority (PA) for BP-1100 modification procurement funds, and USAF/ACB issues the budget authority (BA). PA specifies the quantity of kits to be procured in the applicable fiscal year. HQ AFSC issues a Form 56, and HQ AFLC issues a PAD directing modification implementation.

Normally, the weapon SM at the appropriate ALC manages the modification program. He is responsible for accomplishing the Group A engineering and procurement. The Group B kits are normally procured by the System Program Office (SPO) that developed the hardware through a purchase request from the item manager responsible for the end item. Full installation begins after the Group A and B kits have been kit-proofed and a Time Compliance Technical Order (TCTO) has been verified. Kit-proofing provides for trial

installation of the first production kit to verify the hardware, instructions, skills, and special tools. The time required from the MRG review of the MPA through trial installation is usually a minimum of one year.

After kit-proofing has verified the installation, the modification of weapon systems begins. The time required to complete the actual modification of all scheduled weapon systems varies, depending on the number and availability of aircraft to be modified, kit availability, and other factors. It is noted, however, that the time required from SON submission to kit-proofing in this example is three years, excluding development time.

2.2 CLASS IV MODIFICATION PROCESS

2.2.1 Deficiency Reporting

Class IV modifications occur only after program management responsibility has transferred to AFLC. As shown in Figure 2-2, the Class IV modification process can be initiated by either the operating command or AFLC. The operating command submits Class IV A and B modification requirements in the form of deficiency reports to the applicable ALC for review and integration into the budget cycle. AFLC initiates Class IV modifications as a result of its analysis to identify projected deficiencies or obsolescence, to incorporate technological improvements as the opportunity occurs, or to reduce overall costs. Although AFLC may initiate any type of Class IV modification, it is involved primarily in initiating Class IV C because this type of Class IV modification is designed to provide improvements to logistics supportability.

2.2.2 AFLC Initial Processing/Priority Ranking

The appropriate Air Logistics Center prepares and establishes a Material Improvement Proposal (MIP) in accordance with AFLC Regulation 66-15. The MIP is essentially a management control system used to ensure that the deficiencies are evaluated and resolved by the appropriate function elements. The ALC accomplishes any preliminary engineering required to define the problem and determines the estimated costs for submission in the budget cycle. Funds planning (Form 775) is accomplished in accordance with the directions provided in AFR 27-8. All budget programs must be covered, including spares, support equipment, software, and installation. Concepts of full funding (Section 2.1.4) and production-kit lead time away must be complied with. The completed and coordinated Form 775 is then forwarded to AFLC/LO for review and integrated priority ranking of all Class IV modifications. The integrated priority list and Form 775 are then forwarded to the Air Staff (AF/LEX/LEY). [Avionics modifications are also forwarded to the Deputy for Avionics Control (DAC). The DAC reviews the modifications, looks for standardization opportunities, and assures that the latest technology is used in Avionics Acquisition].

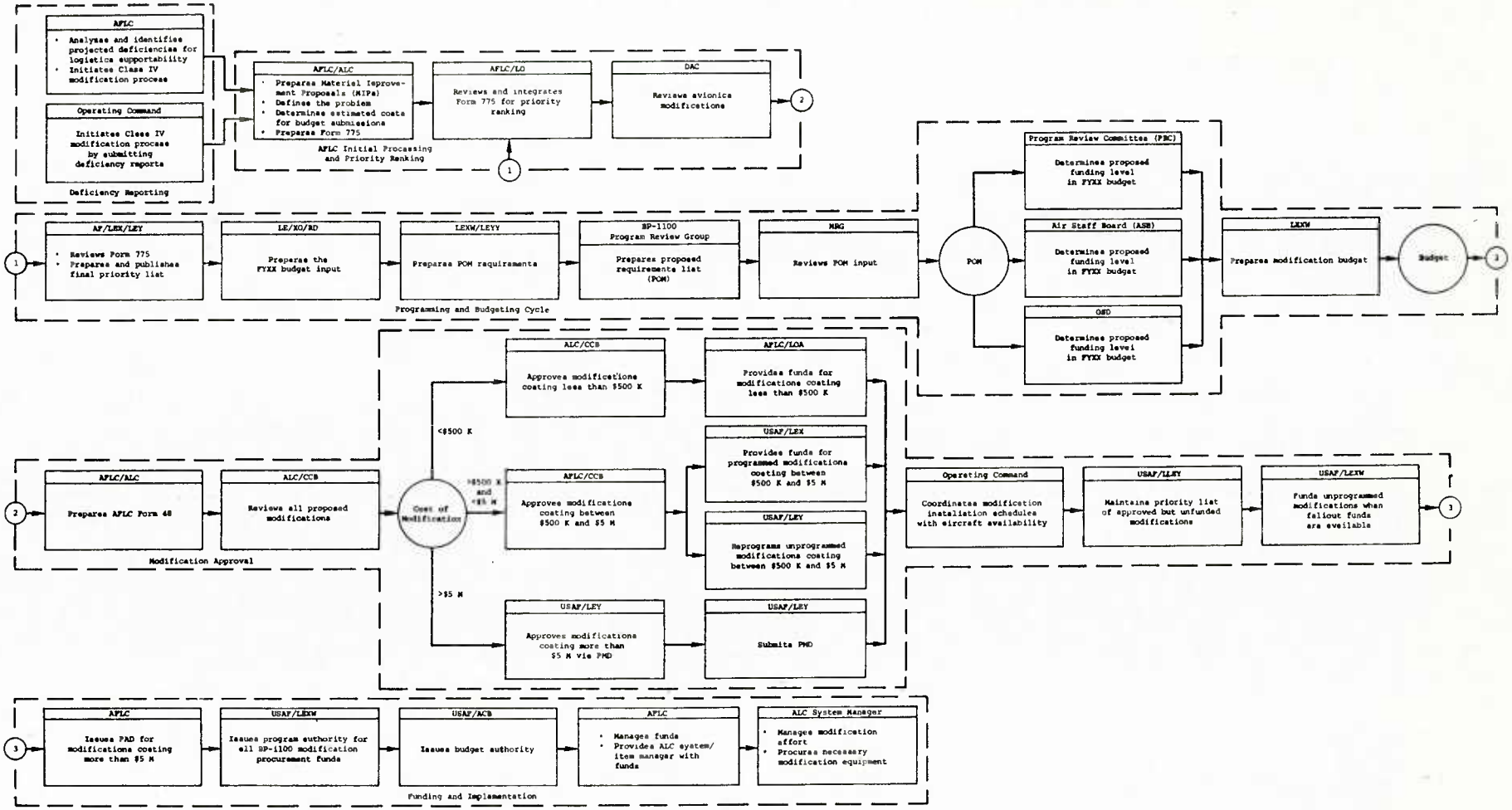

Figure 2-2. FLOW CHART OF CLASS IV AIRCRAFT MODIFICATION

2.2.3 Programming and Budgeting Cycle

The Air Staff reviews Form 775, and LEYY prepares and publishes a final priority list. LE, XO, and RD then jointly prepare the FYXX budget input. Class III, IV, and V modifications compete for BP-1100 funding. The modification budget then competes for funding within the total Air Force budget.

LEXW and LEYY then prepare the POM requirements on the basis of previous years' unfunded requirements and known new requirements that have surfaced during the last year. The Air Staff BP-1100 Program Review Group prepares the POM. The MRG reviews the POM input for production readiness and completeness.

The POM is then worked through the Program Review Committee (PRC), the Air Staff Board (ASB) structure, and OSD to determine the proposed funding level in the FYXX budget. LEXW prepares the modification budget within the constraints of the POM. The Class IV portion is based on the published priority list. The same review cycle through OSD is conducted in order to obtain the President's budget submission. Budgetary submissions follow the DoD cycle described in Section 2.1.4.

It should be noted that for Class IV modifications a given modification may be funded even though it was not approved in the budget cycle, provided it is approved by the appropriate Configuration Control Board (CCB) and its priority dictates early funding. The reason for this apparent anomaly is that BP-1100 funds can be transferred from budgeted but unapproved Class IV modifications to unbudgeted but approved modifications that are ready for funding.

2.2.4 Modification Approval

AFLC Form 48 (Configuration Control Board Item Record) is prepared by the ALC. This activity completely defines the modification proposal and summarizes information for any supporting modifications and reflects total program cost. Form 48 is normally proposed after a modification is programmed, but it can be prepared concurrently with Form 775 or in advance of the budget cycle, depending on the urgency of the requirement. The ALC/CCB reviews all proposed modifications, provides final approval for those costing less than $500,000, and forwards other approved modifications to the AFLC/CCB for further processing. The ALC requests funds from AFLC/LOA for approved modifications costing less than $500,000. The Operating Command coordinates the proposed modifications to assure that aircraft are available to meet the proposed installation schedule.

The AFLC/CCB reviews and approves or disapproves modifications requiring funding greater than $500,000 and less than $5 million. For those modifications costing more than $5 million, Form 48 is forwarded to USAF/LEY for final approval. AFLC requests BP-1100 funding from USAF/LEX for programmed, approved modifications with a total cost lower than $5 million. Approved but unprogrammed modification requirements costing less than $5

million are forwarded by AFLC to USAF/LEY for possible reprogramming. Potential sources of funds are recommended by AFLC when the modification priority dictates immediate action.

Within the Air Staff, LEYY maintains a priority list of approved but unfunded modifications. LEXW then funds unprogrammed modification requirements, if fallout funds are available, on the basis of the LEYY priority list.

For modifications costing more than $5 million, approval is given by USAF/LEY via PMD to AFLC, providing specific program guidelines.

2.2.5 Funding and Implementation

In response to the PMD, AFLC issues an implementing PAD for modifications of more than $5 million. USAF/LEXW issues program authority for all BP-1100 modification procurement funds, and USAF/ACB issues the budget authority, thus authorizing funds expenditure. AFLC manages the funds for Class IV modifications and provides the ALC system manager/item manager with funds after modification approval and upon receipt of an ALC request.

The ALC system manager is responsible for management of the modification effort. He procures the necessary kits and materials to accomplish the modification and ensures that support equipment, spares, and trainers are procured in time for the first kit delivery. Actual modification begins after kit-proofing has verified the installation. The time required to complete the modification of all scheduled weapon systems is dependent on the number and availability of aircraft to be modified, kit availability, and other factors.

Unlike the routine Class V modification process, certain Class IV modifications (e.g., safety-related) may be accomplished in an accelerated manner. It is possible for a Class IV A safety modification to be completed, from discovery through correction of deficiency, in less than six months.

2.3 SUMMARY

This brief overview of the Class IV and V modification processes indicates that both are complex. The priority establishment, approval, and funding mechanisms that must be accomplished to ensure an orderly process are often time-consuming. Chapter Three presents the opinions of a group of Air Force modification managers on what they consider to be key problems associated with these processes.

CHAPTER THREE

SURVEY RESULTS

This chapter presents the results of the survey of the Air Force modification management community, conducted to obtain opinions and observations on problems and issues in aircraft modification management.

The survey was accomplished in two forms. First, a multiple-choice questionnaire was mailed to a cross section of 90 organizations of the development, support, and user communities, as well as the Air Staff. Second, structured interviews were conducted with 18 selected senior Air Force civilian (GS-14 and -15) and military (04 through 07) modification managers. The interviews employed the same questions as the mailed questionnaire, but in an "open ended" form. The questionnaire consisted of nine questions developed from issues frequently discussed within the modification management community. They were developed after our review of previous studies and were based on problems and issues in modification management identified in these studies.

3.1 EXPERIENCE OF RESPONDENTS

Certain demographic data were obtained from those who responded, whether through the questionnaire or in interviews, to determine the background and experience of the survey participants. These data are summarized in Table 3-1. To determine the currency of this experience, participants were asked to indicate what portion of their modification management activity occurred within the last five years. The average response for all participants was 3.4 years.

In addition, responses are divided into four groups in order to gain insight into the perspective of the respondents. Of the survey respondents, 37 percent are from the support community, 30 percent from the user community, 19 percent from the development community, and 14 percent from the Air Staff.

3.2 SURVEY RESULTS

A total of 217 responses are incorporated in this study. Table 3-2 presents the overall results of the survey. A detailed discussion of the

Table 3-1. EXPERIENCE OF RESPONDENTS	
Experience	Percentage of Respondents
Total Years of Modification Experience	
1 through 5	53
6 through 10	19
11 through 20	23
More than 20	5
Experience by Modification Class	
Mainly Class IV	36
Mainly Class V	28
Equal combination of Class IV and Class V	36

responses to all survey questions appears in the following sections of this chapter. Significant comments related to each question are included in Appendix B. Although the primary purpose of this chapter is to present survey results, qualitative judgments have been included where they might contribute to clarity. The survey responses are analyzed in detail in Chapter Four.

3.2.1 Question 1: Modification Requirements Definition

Respondents were requested to rate modification requirements as follows with respect to definition:

A. Are as specific as could be reasonably expected

B. Are poorly defined

C. Are too specific, i.e., tend to exclude reasonable alternatives

D. Other

As shown in Figure 3-1, the majority of all respondents answered that modification requirements were reasonably well defined, but in many of the cases qualified the answer by saying that the process had many inherent problems. The development community response was evenly divided between reasonably well defined and poorly defined requirements. This could be attributed to the fact that AFSC and its product divisions are responsible for developing the Group B subsystems that must respond to requirements and, as such, they perceive a greater need for sharper definition.

A significant portion of the development, support, and user communities believed that requirements definition could be improved, including those

Table 3-2. SUMMARY RESULTS OF SURVEY QUESTIONNAIRE

Response Category	Percentage of Response by Survey Question Number								
	1	2	3	4	5	6	7	8	9
Development Community (19 Percent of All Survey Respondents)									
A	42	21	6	26	57	50	29	3	25
B	42	70	16	49	29	0	10	10	25
C	10	3	69	23	14	31	45	84	48
D	6	6	9	2	0	19	16	3	2
Support Community (37 Percent of All Survey Respondents)									
A	54	14	25	26	36	44	20	0	27
B	30	77	47	51	17	16	48	23	24
C	6	7	22	18	27	27	19	72	36
D	10	1	6	5	20	13	13	5	13
User Community (30 Percent of All Survey Respondents)									
A	48	6	15	19	49	57	39	4	28
B	28	92	34	51	16	4	22	16	37
C	22	0	49	19	31	34	31	76	32
D	2	2	2	11	4	6	8	4	3
Air Staff (14 Percent of All Survey Respondents)									
A	65	15	4	35	44	48	20	0	26
B	17	85	29	42	19	22	27	9	30
C	9	0	63	15	33	11	43	91	37
D	9	0	4	8	4	19	10	0	7
Combined*									
A	51	14	15	25	45	49	27	2	27
B	30	81	35	49	19	10	30	16	29
C	12	3	45	19	27	28	31	78	37
D	7	2	5	7	9	13	12	4	7

*Combined response is the weighted average of responses for each community or agency.

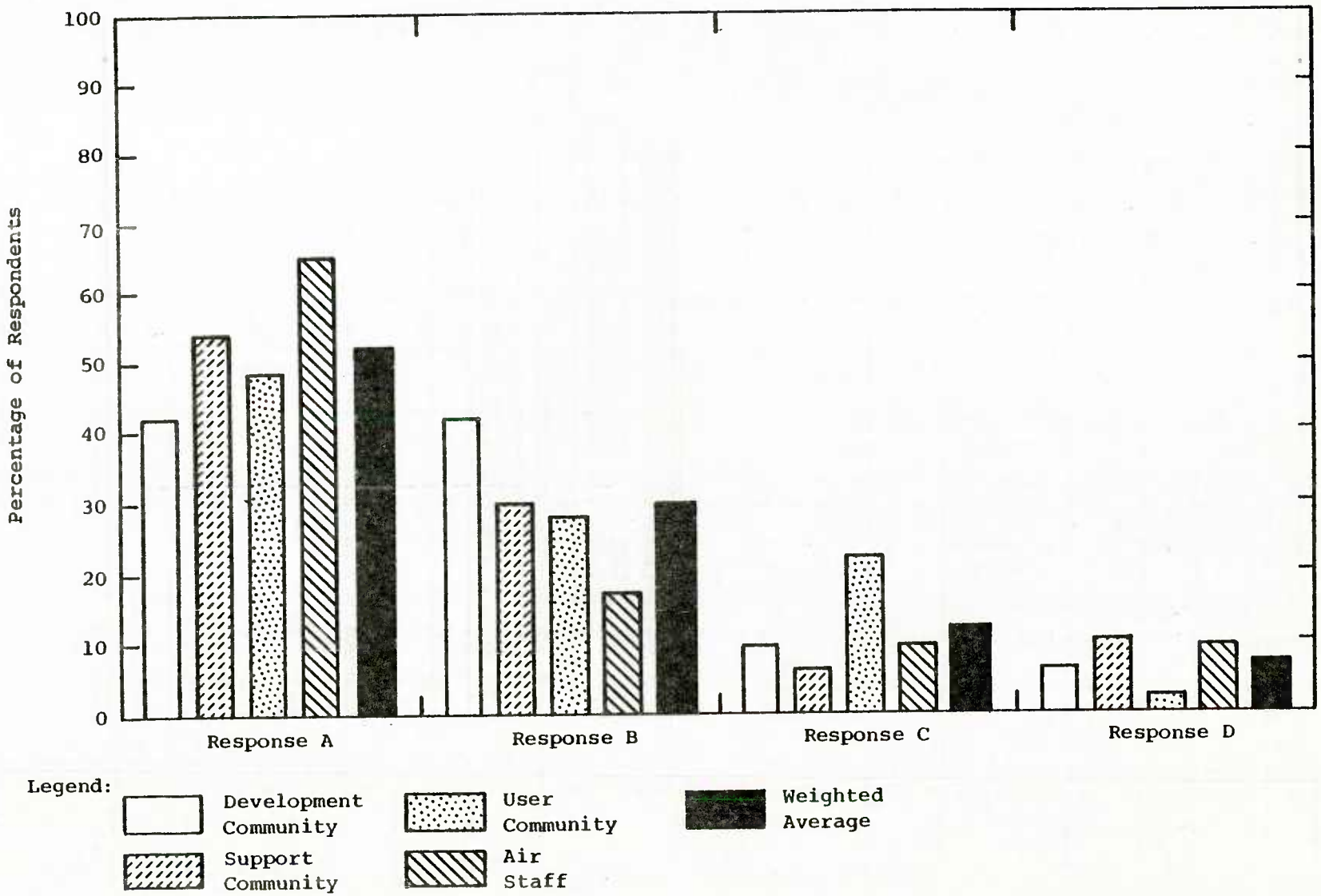

Figure 3-1. DISTRIBUTION OF RESPONSES TO QUESTION 1

which gave both the A and B responses. Significant issues raised by these respondents included lack of "total weapon system" considerations, floating baselines, requirement's loss of currency during the lengthy overall modification process, the driving of requirements by technology instead of by operational mission considerations, lack of user accountability for requirements, coordination and common understanding of issues, and lack of Class IV reliability and maintainability advocacy.

3.2.2 Question 2: Timeliness of the Modification Requirements Process

Respondents were requested to rate the modification requirements process as follows with respect to timeliness:

A. Is an appropriately considered process

B. Takes too long to provide timely solutions

C. Is too short to adequately consider all decision aspects

D. Other

As shown in Figure 3-2, an overwhelming majority of the respondents believed the process was too long to provide timely solutions. The majority of the comments dealt with the length of the entire modification process, including requirements, programming, budgeting, development, and implementation.

Many of the comments regarding question 2 dealt with the fiscal aspect of the modification process (budgeting, funding, and procurement). Although these aspects of modification management fall outside the requirements approval process per se, a significant number of persons responding to the question considered them a primary source of delay. Other sources of delay in the overall modification process were associated with the post-requirement approval process, including the overall CCB process and, specifically, Form 48 changes. Fragmented management authority was also perceived to be an overall source of delay because of the need for numerous cross-checks and coordination. Respondents also stated that simplified procedures were needed for low-cost and low-risk modifications.

3.2.3 Question 3: Criteria for Modification Priorities

Respondents were requested to rate criteria for modification priorities as follows:

A. Should be clearly defined in quantitative figures of merit

B. Should be subjectively determined on the basis of operational and cost factors

C. Should be expressed as a balance of qualitative and quantitative factors

D. Other

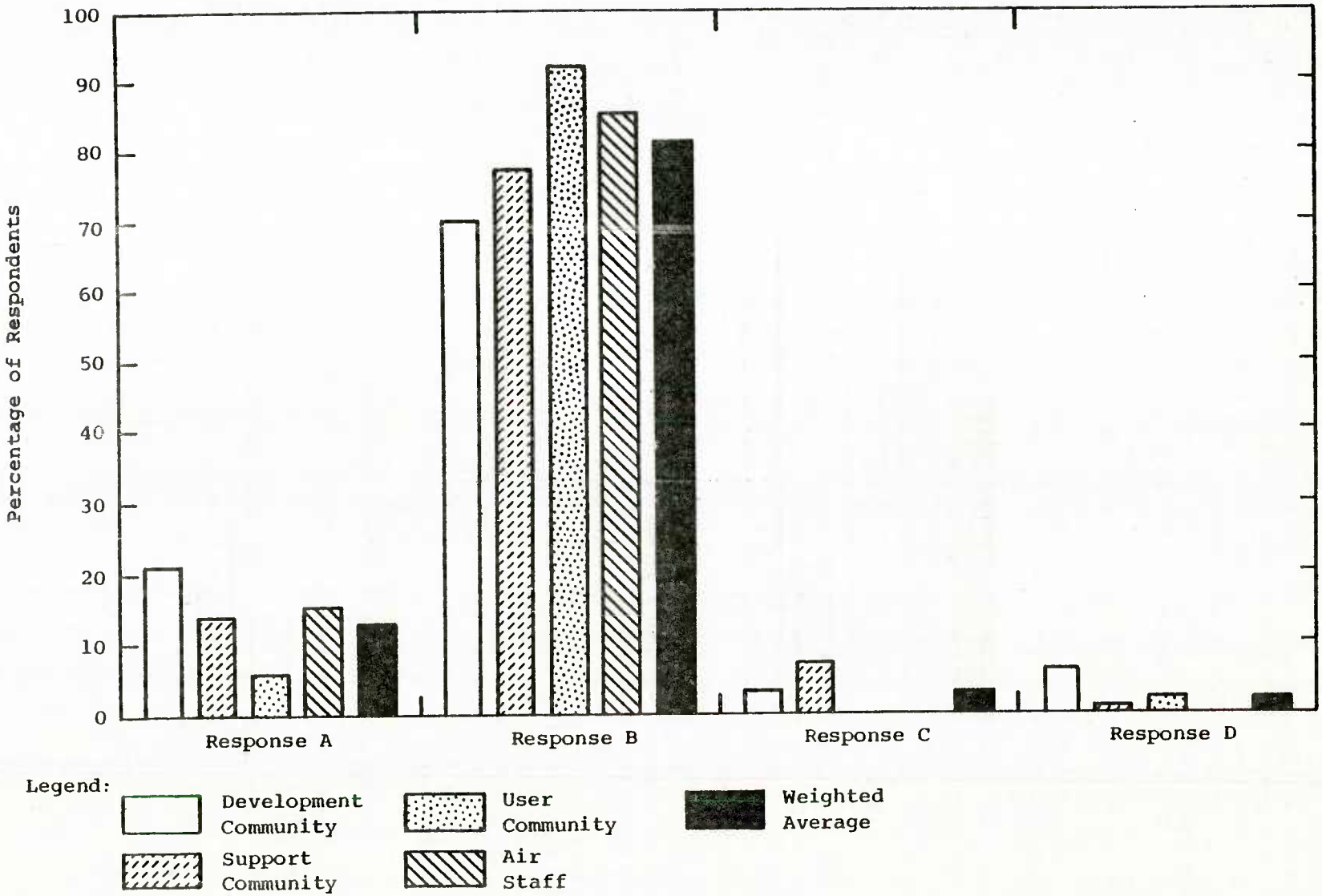

Figure 3-2. DISTRIBUTION OF RESPONSES TO QUESTION 2

Response to question 3 was mixed. As shown in the Weighted Average column of Figure 3-3, the majority of all respondents believed that priorities should be subjectively determined on the basis of operational and cost factors or should be expressed as a balance of qualitative and quantitative factors. Although very few favored strictly quantitative figures of merit (those who did were the support community, which regularly uses a rigorous economic payback equation to set priorities for certain Class IV modifications), the largest percentage of those responding to this question believed that quantitative criteria should be used to balance qualitative criteria in determining modification priorities. Comments on this question revealed that there are problems in establishing priorities because of a lack of adequate tools or figures of merit, inappropriate priority groupings, and a general lack of process structure.

3.2.4 Question 4: Hardware Development and Hardware Implementation as Separate and Distinct Activities

Respondents were requested to rate hardware development and implementation for modification programs as follows:

A. Are separate and distinct activities that can be managed independently by AFSC and AFLC

B. Should be assigned to either AFSC or AFLC from "cradle to grave"

C. Should fall under one line of authority and responsibility across command lines at the Air Staff level

D. Other

As shown in Figure 3-4, approximately 50 percent of those responding chose answer B. Many of the comments, however, suggest that although answer B might have been the "best" answer among those available, the real problem is believed to be caused by a lack of coordination, inadequate PMRT transitions, and less than desirable SPO/DPML and ALC/MAA interfaces. Many of the respondents believe that although development and integration activities are separate and distinct, they must be managed in a cooperative manner, with constant communication and coordination by all involved. To work properly, the PMRT process must be a gradual transition. Many comments reflected a need for an overall program office to oversee modification management activities of both AFLC and AFSC. Many perceive as a significant problem area a lack of concern on the part of developers for support aspects of modifications.

3.2.5 Question 5: Modification Management Function at the Air Staff Level

Respondents were requested to rate the modification management function at the Air Staff level as follows:

A. Is an arbitrary process, of which the outcome is largely dependent on the persuasiveness of the PEM

B. Results in too much involvement in the "working level" management of modification programs (micro-management)

3

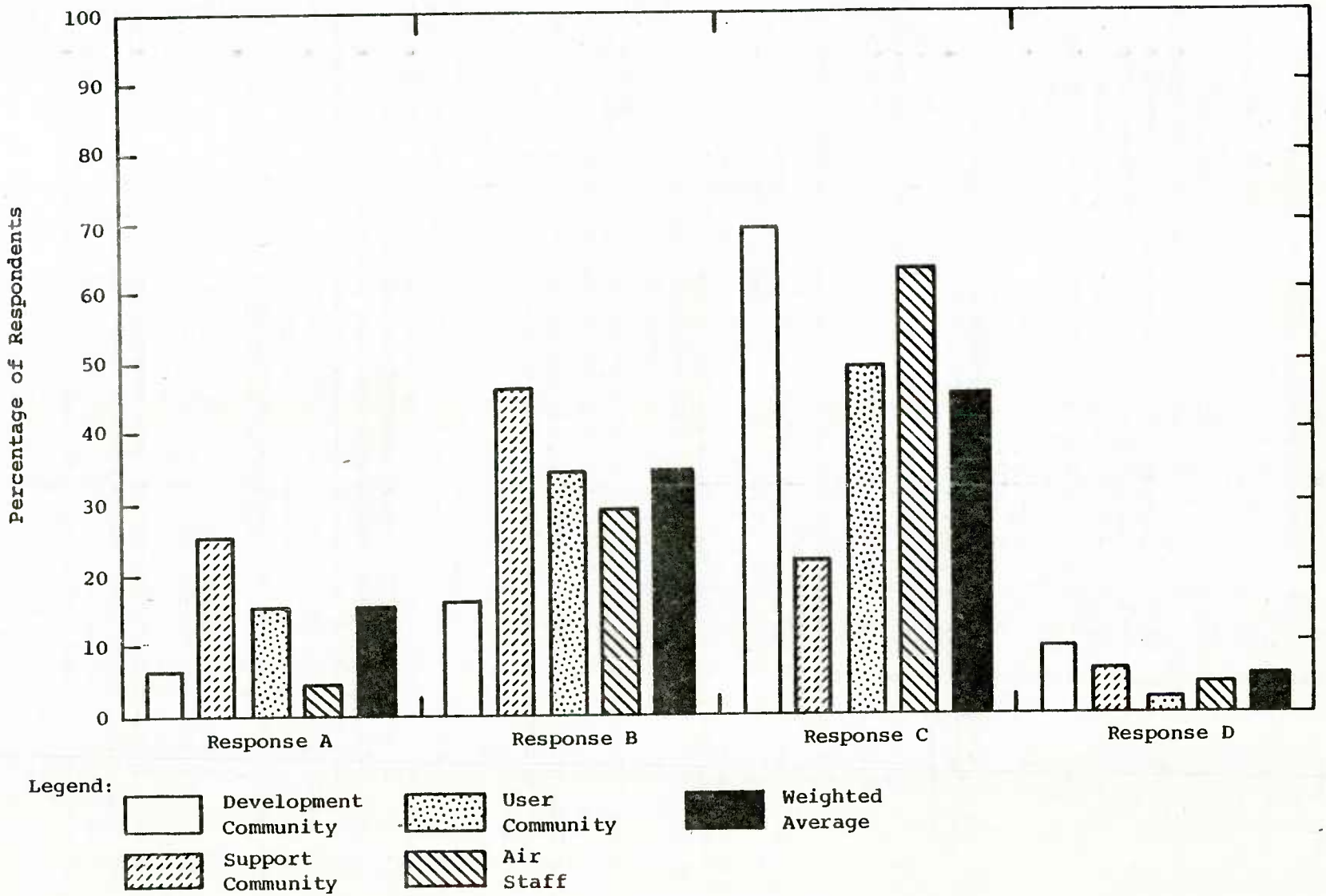

Figure 3-3. DISTRIBUTION OF RESPONSES TO QUESTION 3

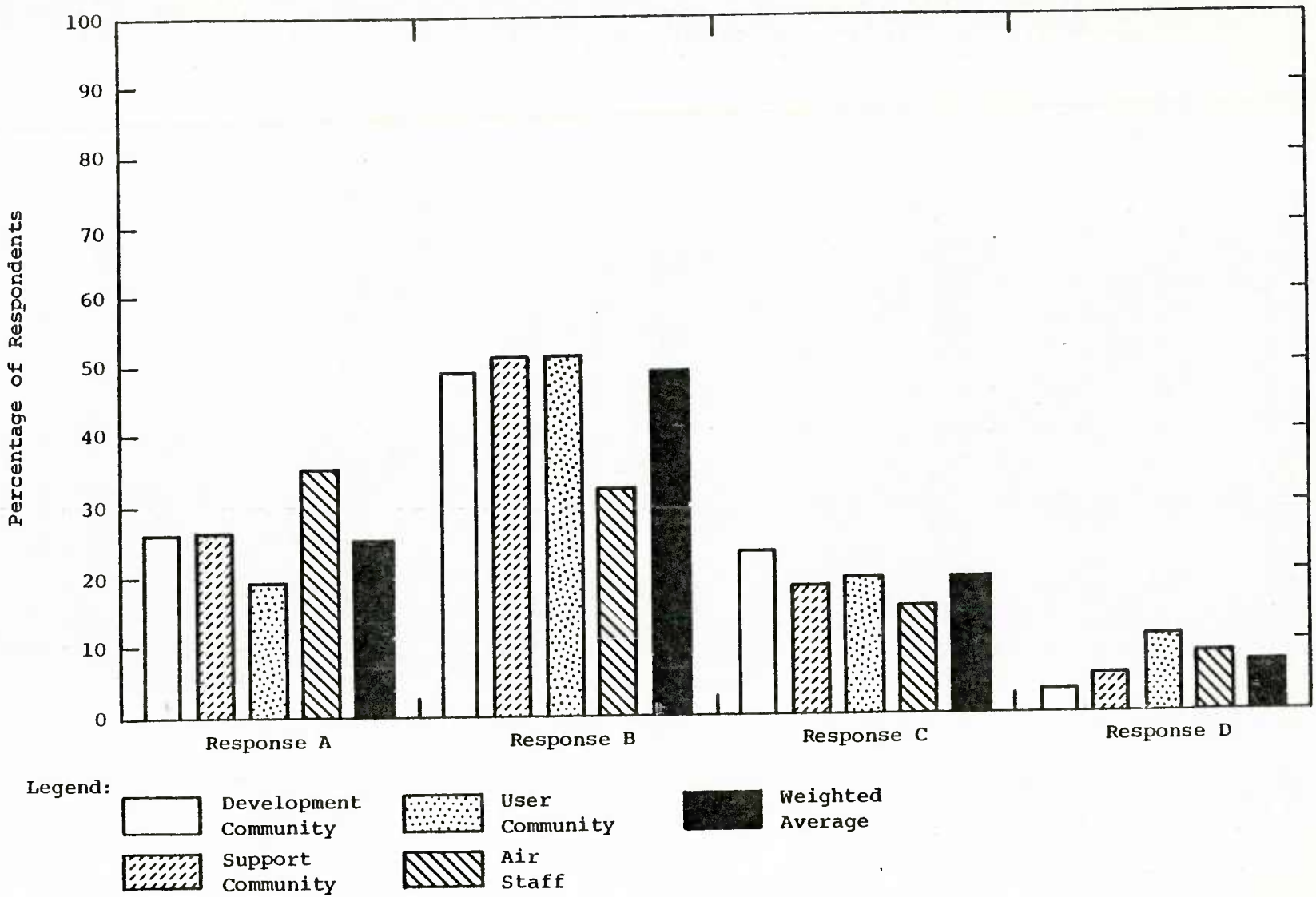

Figure 3-4. DISTRIBUTION OF RESPONSES TO QUESTION 4

C. Provides the needed Air Staff support and involvement regarding the modification process at the field level

D. Other

As shown in Figure 3-5, the responses to question 5 were somewhat scattered; the greatest response indicated that the Air Staff modification management process was arbitrary, with the outcome for a given program mostly dependent on the persuasiveness of the PEM. The second-largest response for all except the development community indicated that the Air Staff provides the needed support and involvement at the field level. The second-largest response for the development community was that the Air Staff was involved in too much micro-management at the working level.

The majority of the comments critical of the Air Staff modification management function (including comments by Air Staff officers) were in one of two categories: inadequate evaluation of requirements and inefficient or inappropriate staffing processes and organization (including problems with the PEM advocacy process).

3.2.6 Question 6: Modification Funding Process

Respondents were requested to best characterize the modification funding process as follows:

A. An artificially difficult coordination environment imposed by the requirement to use three-year procurement funds for hardware and one-year O&M funds for installation

B. A consistent, methodical process that determines the equitable distribution of modification funds

C. A source of program delays because of the SM's and SPO's inability to move funds quickly from one line item to another

D. Other

As shown in Figure 3-6, the majority of those responding to question 6 believed that the modification funding process was either an artificially difficult coordination environment or a source of program delays. The development, support, and user communities were fairly consistent in their response; however, the second largest Air Staff response indicated that modification funding is a consistent, methodical process. This difference might be attributable mostly to perspective, since the Air Staff determines and largely carries out funding policies, which the other three communities must then accommodate.

The criticisms of the funding process can be divided into four general areas: flexibility, response time, division of funds, and budget planning. The principal area of comment was the lack of flexibility in the modification funding process. This criticism included restrictions on types of funds that can be used for given applications, as well as the lack of discretionary budgets for field managers' use. Another criticism asserted

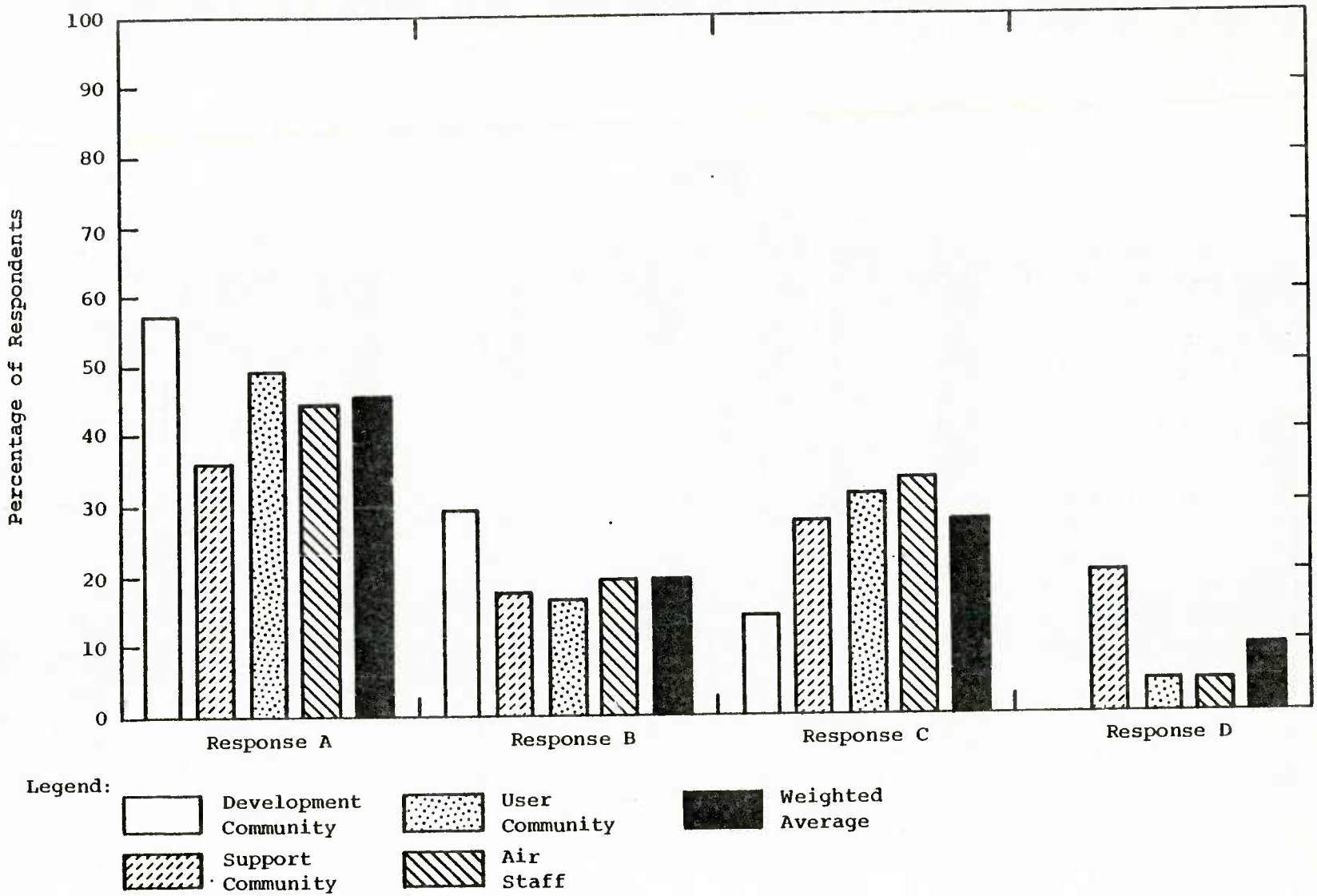

Figure 3-5. DISTRIBUTION OF RESPONSES TO QUESTION 5

35

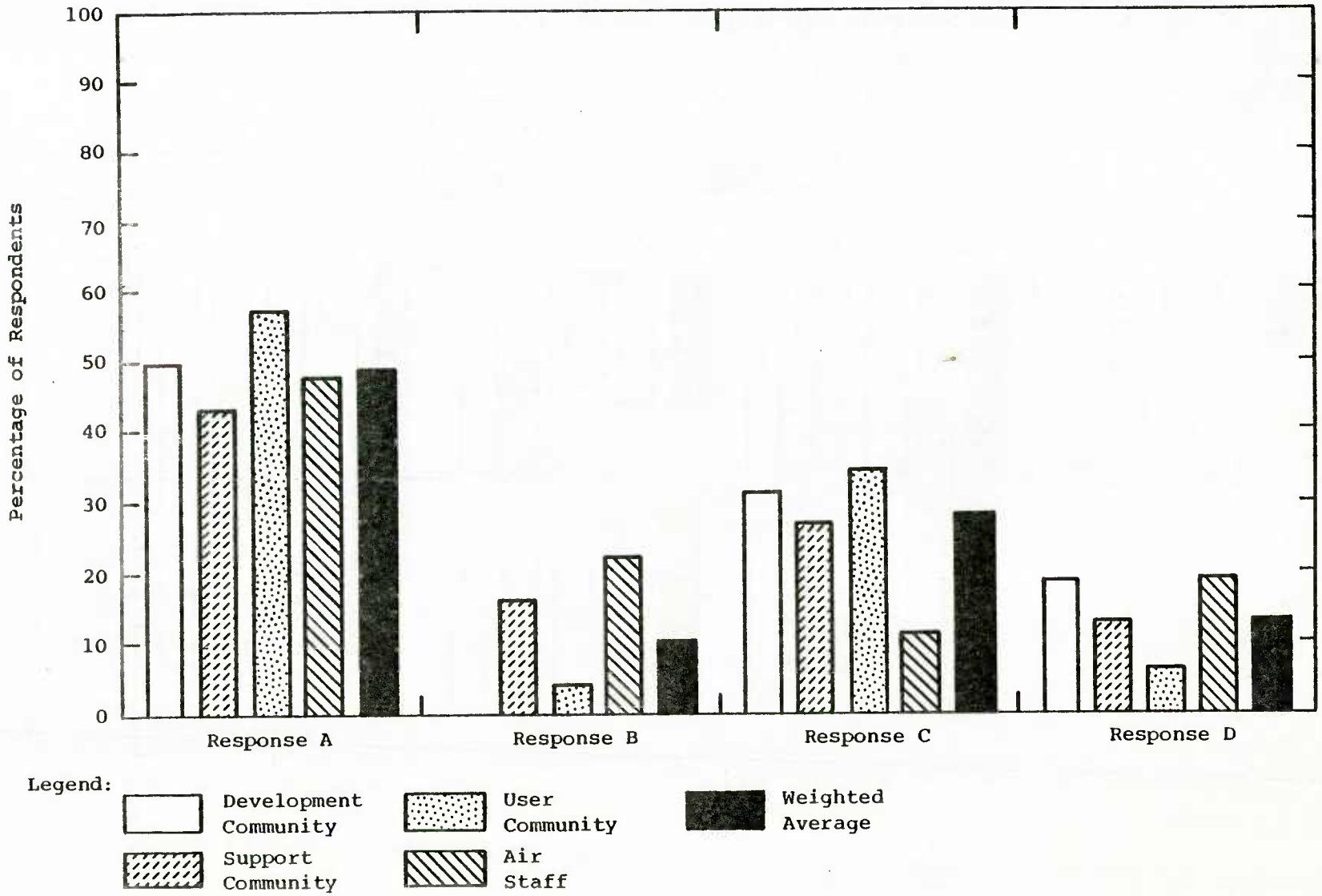

Figure 3-6. DISTRIBUTION OF RESPONSES TO QUESTION 6

that the funding process was too slow and a primary source of delay in the modification process. Some respondents believed that modification funds are inappropriately divided and should be grouped not by modification class but by weapon system. Inadequate long-range modification budget planning was also viewed as an area of concern.

3.2.7 Question 7: Cost Estimating for Planned Modifications

Respondents were requested to rate cost estimating for planned modifications as follows:

A. Is not a serious deficiency in the modification process

B. Is inadequate because of a lack of cost-estimating tools or data

C. Is inadequate because of a lack of understanding of or improper use of tools already available

D. Other

As shown in Figure 3-7, the overall response to this question was mixed, with about one-third answering that cost estimating is not deficient, one-third that it is deficient because of a lack of tools or data, and one-third that it is deficient because of a lack of understanding the available tools.

Most of the development community and the Air Staff attributed the deficiency to a lack of understanding of available tools, while most of the support community response attributed it to a lack of tools or data. The largest user response indicated that there was not a deficiency in cost estimating. The reason for this response might be that since users are not responsible for modification-cost development, they are not aware of a problem. The support community, on the other hand, must develop modification costs and perceives a problem with the required tools and data. It is possible that the Air Staff and development community responses reflect the fact that the Air Staff and AFSC (MAJCOM level) are interested primarily in "order of magnitude" estimates that can be used to define and establish priorities for the overall development and modification budget. From this perspective, they see no need for complex tools to determine costs in minute detail.

Other responses indicated that cost-estimating deficiencies result from a lack of early system definition, hasty proposal of costs, and the outdating of cost estimates because of the lengthy modification process.

3.2.8 Question 8: Weapon System Integration Architectures

Weapon system integration architectures do not always lend themselves to the incorporation of new subsystems introduced as a part of a modification program. Respondents were requested to rate the integration architecture as follows:

A. Should be left to the discretion of the aircraft developer

B. Should be established within strict standards established at the AFLC or AFSC level

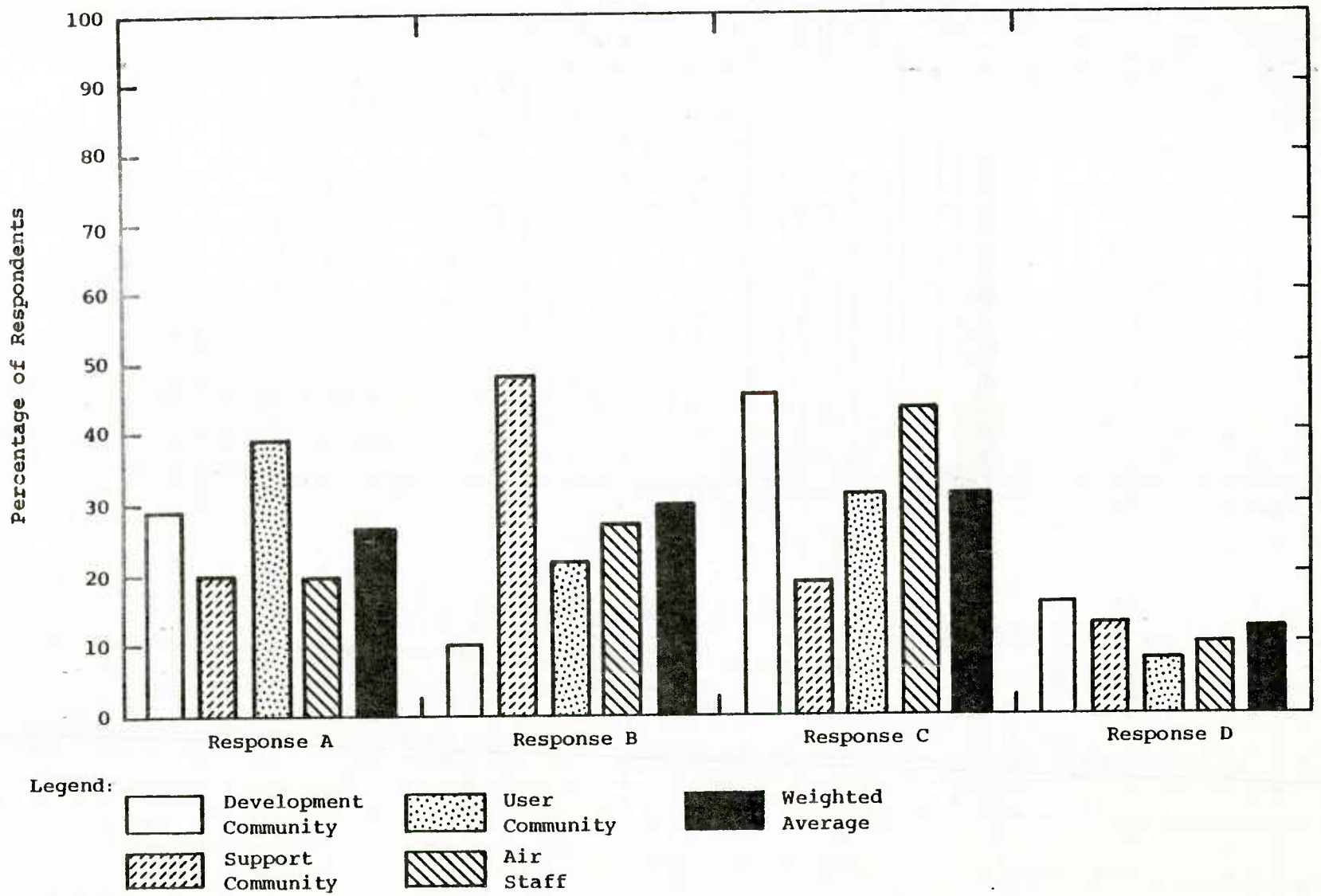

Figure 3-7. DISTRIBUTION OF RESPONSES TO QUESTION 7

C. Should have "envelopes" of interface requirements that leave some degree of flexibility

D. Other

As shown in Figure 3-8, the majority of all responses indicated that answer C was the preferred choice. Individual community responses were very consistent, with the range of responses for answer C varying from a low of only 72 percent (support community) to a high of 91 percent (Air Staff). The majority of the comments for question 8 indicated a need for interface standards and for more advanced planning of future architectural standards.

3.2.9 Question 9: Impact of Modifications on Weapon System

Respondents were requested to identify from among the following the reasons for the adverse effects of weapon system modifications made to support the installation of new equipment in older aircraft:

A. Inadequate engineering in the early stages of a modification program

B. Numerous changes in the new hardware design by the time it is integrated into the weapon system

C. Lack of communication between the subsystem developer and the weapon system manager

D. Other

As shown in Figure 3-9, the responses to question 9 were mixed. The largest overall response indicated that the problem is most frequently due to a lack of communication between the subsystem developers and the weapon system manager. The second largest response indicated that the problem is most frequently the result of numerous changes in the new hardware design by the time it is integrated into the weapon system. The third largest response indicated that the most probable cause is inadequate engineering in the early stages of a modification program. Several significant issues were raised by various respondents. One recurring comment indicated that the problem is primarily the lack of past planning and that this trend needs to be reversed by active planning for future standards as well as implementation of present standards. Many respondents were of the opinion that the problem is due to inadequate engineering early in the modification effort as well as a lack of adequate technical management throughout the program. Others who commented believed that the problem is simply one of not having sufficient growth capability built into early aircraft designs. Additional comments attributed the problem to failure to freeze the design of modifications in process and the "pushing" of immature technology.

3.2.10 Question 10: Most Critical Issues

Question 10 asked what is believed to be the most critical issue preventing more effective modification management today. Although individual

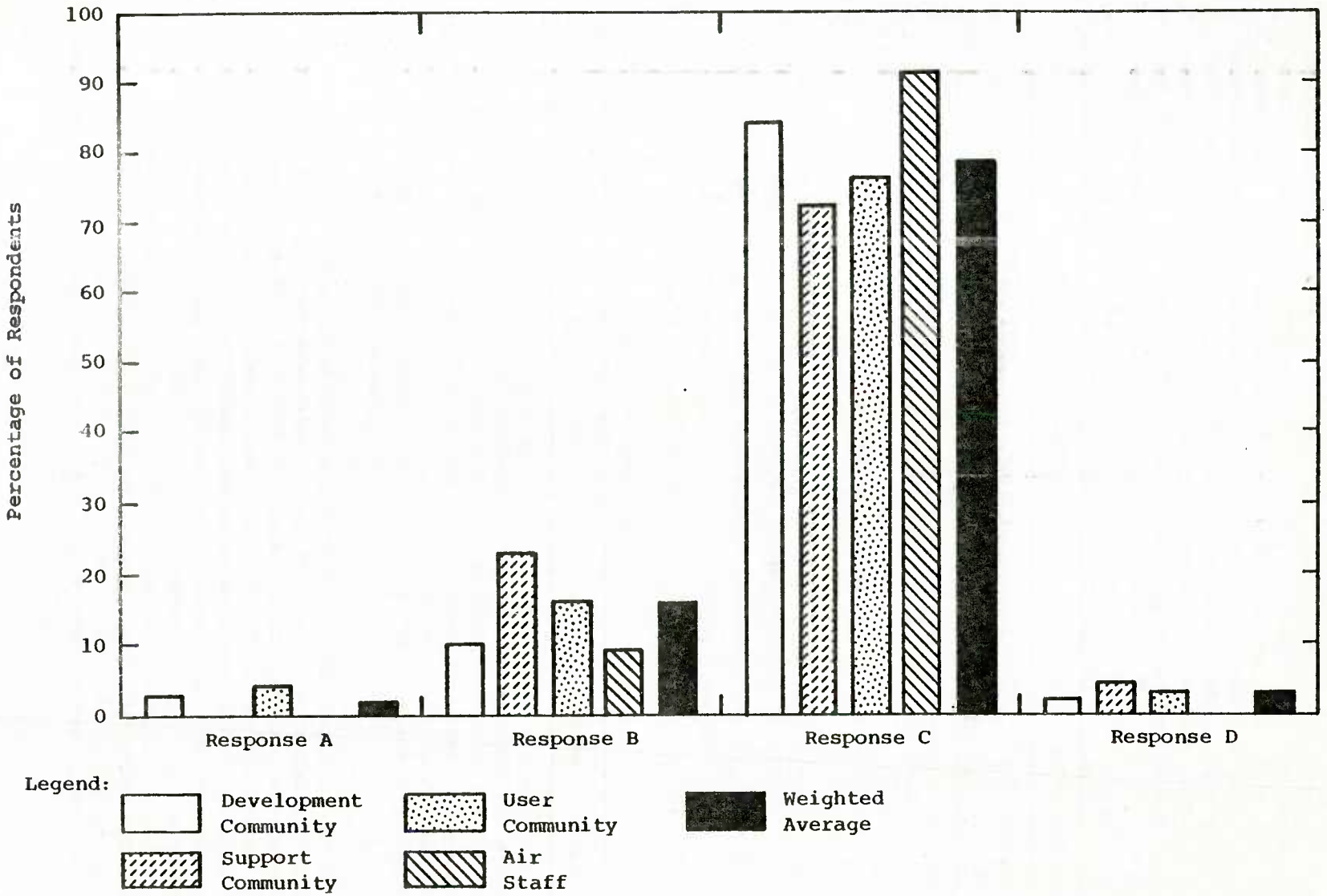

Figure 3-8. DISTRIBUTION OF RESPONSES TO QUESTION 8

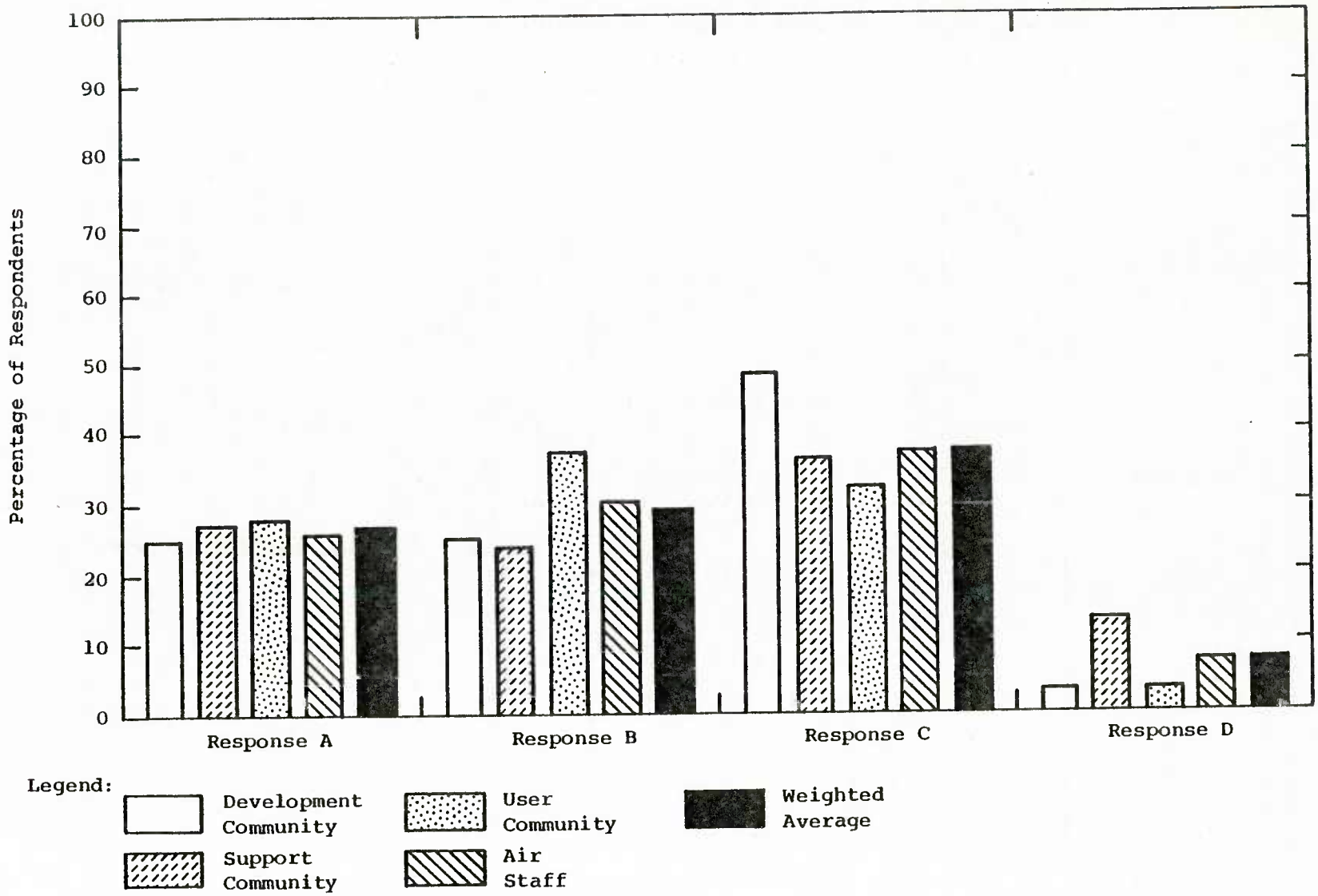

Figure 3-9. DISTRIBUTION OF RESPONSES TO QUESTION 9

responses varied widely, the majority (92 percent) were categorized as shown in Table 3-3. These categories are broken down by community in Table 3-4. Forty-two percent of the comments indicated that the overall modification process was too complex and slow. Some reasons advanced for modification process complexity and delay were requirements validation, modification approval cycle, procurement delays, too many coordinations and reviews, too much paperwork and "red tape," and the length of the budget cycle.

Table 3-3. CRITICALITY RANKING OF MODIFICATION MANAGEMENT ISSUES

Rank	Issue	Percentage of Responses
1	Modification Process Too Slow, Cumbersome, or Complex	42
2	AFSC/AFLC Split Management	19
3	Lack of Weapon System Master Modification Planning	12
4	Lack of Reliability and Maintainability Aspects or No Lifetime Developer Accountability	8
5	Lack of Understanding of Modification Process	6
6	Inadequate Requirements Definition Process	5
7	Other	8
	Total	100

The next most frequent comment indicated that the AFSC/AFLC split-management issue was also viewed as a significant problem. Many comments on this issue indicated that strong centralized management is needed to ensure a proper AFLC-AFSC interface. Others believed that a single agency or office should have overall responsibility for a weapon system from "cradle to grave."

Many respondents said that involvement by AFLC early in the development cycle is required to ensure that integration and supportability aspects are adequately addressed. The lack of master planning by weapon system was viewed as the most critical issue by 12 percent of the respondents. This lack is believed to create duplication of engineering effort, make integration more difficult, and affect overall weapon system capability. Closely associated with the AFSC/AFLC split-management problem was the general lack of adequate attention to the reliability and maintainability factor of modifications. Some respondents maintained that more active AFLC participation is required prior to PMRT in the form of AFLC-established acceptance criteria (e.g., MTBF, spares) before the production decision.

Table 3-4. DISTRIBUTION OF RESPONSES ON CRITICAL ISSUES				
Issue	Number of Responses			
	Development Community	Support Community	User Community	Air Staff
Modification Process Too Slow, Cumbersome, or Complex	8	28	13	7
AFSC/AFLC Split Management	6	6	5	8
Lack of Weapon System Master Modification Planning	6	5	5	0
Lack of Reliability and Maintainability or No Lifetime Accountability	1	2	2	5
Lack of Understanding of Modification Process	1	5	1	1
Inadequate Requirements Definition Process	1	3	1	1
Other	0	4	3	4

Others indicated that the lack of developer lifetime accountability for the modified weapon system results almost always in the trading of supportability for capability. Six percent of those commenting said that the most critical issue is a lack of understanding of the modification process and, compounding this issue, the lack of a formal training program for modification managers.

Finally, five percent of the respondents stated that the requirements definition process is inadequate. These comments indicate that the problem is caused by requirements that are inadequately defined and unrealistic; a lack of firm definition, leading to revisions; and a general lack of control and discipline in the system. The remaining eight percent of the responses were widely varied and were not categorized. Appendix B lists significant comments obtained from question 10, edited for brevity and clarity.

3.3 SUMMARY

The responses to the multiple-choice questions, together with the comments received from the survey, indicate that the Air Force modification managers are aware of numerous problems with the existing modification management system. Questions 1, 2, and 3 were designed to determine the

modification management community's opinions concerning the requirements and priority-setting process. Responses indicate that some significant issues are: (1) the process is too long, (2) requirements are frequently poorly defined and unstable, (3) there is a lack of ranking and modeling tools, and (4) proposed modifications are inappropriately grouped for the setting of priorities.

Questions 4 and 5 were designed to elicit opinions regarding organization and staffing issues in modification management. A major portion of the responses indicated that the PMRT process is lacking in continuity and that a single management authority should oversee development and implementation for modifications. Other comments included dissatisfaction with the organization and staffing processes for modification at the Air Staff.

Questions 6 and 7 related to the funding and budgeting process for modifications. Respondents perceived problems in the areas of cost-estimating tools, procurement procedures, the funding and budgeting process, and long-range planning.

Questions 8 and 9 dealt with weapon system integration issues. The majority of the comments in response to these questions indicated a need for more interface standards, more planning for future integration architecture, and increased communication between the subsystem developer and the weapon system manager.

CHAPTER FOUR

ANALYSIS OF SURVEY RESULTS

On the basis of the descriptions provided in Chapter Two, it is evident that the modification process is (quite often of necessity) time-consuming and complex. Most modifications involve costly and complicated changes to weapon systems. Frequently, extensive coordination is required to ensure that all technical and operational aspects have been adequately addressed. In this chapter the results of our survey of the modification management community are classified and analyzed to provide the basis for a structured resolution of key issues.

4.1 CLASSIFY AND DEFINE IMPACT OF PROBLEM AREAS

It was apparent from the literature study and from the response to our survey that the perceived large number of issues in modification management were in fact a mixed set of causes and effects. To make it possible to deal with a manageable number of significant problem areas, these issues were segregated into their logical relationships.

The first step in the analysis was to define the effect of major problem areas on the current modification process. On the basis of our review of the survey results, as well as other studies and formal guidance, the following six logical categories of problem areas were identified:

- Policy
- Technical
- Planning
- Business
- Requirements
- Funding and budgeting

The cause-and-effect relationships of the significant individual contributing elements to the above-listed categories were examined in light of the current modification process as described in Chapter Two. For

example, if the obligation availability of the various appropriation categories (i.e., procurement funds, three years; RDT&E funds, two years) was determined to create interruptions or gaps in program funding, the cause-and-effect relationship would be cause: appropriation categories; effect: discontinuity in funding. The objectives of this analysis were to raise problem areas to the modification process and to provide the basis for developing a hierarchy of key issues, which are described in Section 4.2. The cause and effect summaries for the six categories of problem areas are presented in Tables 4-1 through 4-6.

Table 4-1. POLICY

Cause	Effect	Remarks
Diverse interests among Air Staff agencies	Lack of firm guidance, changing priorities	This could actually provide good check-and-balance system to avoid arbitrary choices based on one party's interests.
PEM advocacy	Tends to restrict objectivity	--
No single manager	Suboptimum integration of effort during development, acquisition, and support phases	Logistics supportability may be adversely affected.
No formal training	Lack of understanding of modification process, resulting in misapplication	--
No developer accountability for lifetime support aspects	Support aspects not always addressed adequately during development	--
Insufficient AFLC participation prior to PMRT	User capability uncertain, support impaired	--
Inadequate communication/coordination	Independent AFLC and AFSC solution of development and support problems	This can result in a lack of compatibility between development and support aspects of modification.

Table 4-2. TECHNICAL		
Cause	Effect	Remarks
Inadequate costing tools and data	"Back of envelope" estimates, often optimistic; creates reliance on contractor estimates, also often optimistic; cost overruns	All of these areas affect modification costs.
Lack of understanding or inconsistent application of costing tools already available	Inaccurate estimate, delays, and cost overruns	
Lack of interface standards	Proliferated designs; increased integration effort and cost	
Lack of technical tools to set priorities for modifications in terms of cost and MPA benefits	Solutions not always cost-effective	

Table 4-3. PLANNING		
Cause	Effect	Remarks
Lack of weapon-system-level planning for modifications	Integration and space problems; increased cost and downtimes for modifications	All of these areas affect modification costs.
Requirements not baselined; design vacillates	Delays and increased funding requirements	
Lack of long-range planning in architectural concepts and design	Integration designs suboptimum	
Lack of planning capability to group multiple modifications at one time	Creates integration problems, maintenance inefficiency, poor use of aircraft space	

Table 4-4. BUSINESS		
Cause	Effect	Remarks
Inability to negotiate multiyear procurement options	Contractor increases his costs yearly; contractor production line planning is hindered.	All of these areas affect modification costs and schedule.
No procurement negotiation work until funding authority paperwork complete	Procurement cycle is lengthened.	
Inadequate software acquisition policies	Air Force lacks software data/documentation and is tied to contractor for lifetime support.	
Complex procurement procedures, legal process	Procurement cycle is lengthened.	

4.2 HIERARCHY OF CAUSES

To further reduce the issues under consideration, the individual contributing elements that constitute the problem area categories described in Section 4.1 were examined. In this way, multiple elements under common headings were organized to create a hierarchy of key issues. The hierarchies reflect not only the comments concerning survey results (discussed in Chapter Three) and cause-and-effect relationships, but also include the detailed comments from the survey questionnaire provided in Appendix B.

The hierarchical tables are built from the detailed problems specified at the base, to the more generalized key issues displayed at the top of the tree. For example, the allocation-of-resources hierarchy illustrated in Figure 4-1 was created by combining resource-allocation-related causes from the policy, requirements, and technical categories under a common heading called "changing priorities." The "PEM advocacy" cause was then combined with "changing priorities" as contributing to a common subproblem called "lack of firm, consistent direction in Air Staff priority-ranking process." Similarly, causes from the funding, budgeting, and requirements category were combined under a common heading called "inappropriate priority ranking." Finally, this subheading was combined with "lack of firm, consistent direction in Air Staff priority-ranking process" to form the allocation-of-resources tree, or hierarchy, with its attendant three sub-issues at the apex.

Table 4-5. REQUIREMENTS		
Cause	Effect	Remarks
Poorly defined requirements	Program is redirected frequently, changing priorities.	In addition to affecting modification cost and schedule, support package development is delayed by late design changes.
No "systems" look at requirements	Results in individual "black box" requirements.	This may affect mission performance and increase integration time and cost.
Requirements overstated	Real need is clouded; "gold-plating" occurs.	Cost increases, with no increase (or perhaps decrease) in mission performance.
Long time from need to implementation	Requirements become noncurrent; tend to change developments.	Mission performance is affected; costs can increase.
Requirement driven by technology	Solutions rather than need become the basis for requirements.	--
R&M requirements not addressed	Maintenance and downtimes increase.	This increases sorties turnaround times, resulting in decreased mission effectiveness.
No user accountability for requirements	Large cost increases are incurred for a relatively small increase in capability.	Perhaps a cost versus capability trade-off should be required of user.
Class V SON process too slow	Low-cost/low-risk modifications are unnecessarily delayed.	--
Requirements approval process too slow	Delays disrupt orderly requirements planning and prevent timely solutions.	--

Table 4-6. FUNDING AND BUDGETING		
Cause	Effect	Remarks
Budget lead time of two years from requirements to funding	Delay in implementing modifications	--
No flexibility in spending authority level	Time delays; operational impacts due to SM inability to spend limited funds without MAJCOM approval	This can adversely affect the time required to implement minor, low-cost modifications (Class IV).
Funding "color" inflexibility	Inability of AFLC to spend 3600 funds after PMRT causes delays	This increases the time required to implement modifications requiring limited R&D after PMRT.
Time restraints placed on type of money used	Planning and budgeting problems	--
Too many organizations involved in the process to release and allocate funds	Complex funding procedures; delays in moving money result in program delays	Cost increases frequently occur as the result of loss of currency of contractor quotation.
Separation of Class IV and V funding "pots"	Inability to compare value and priority of programs directed toward different objectives (cost reduction versus capability improvement)	--
Travel funds not approved with modification funding approval	Inability to travel to perform necessary coordination	--
Use of unrealistically low inflation factors	Cost overruns	--
Lack of definition of modification when cost estimates are made	Low credibility of cost estimates	--
Low estimates to obtain approval of modification	Cost overruns	--
Inadequate research; hurried estimates	Poor estimates and delays; cost increases	--
Inadequate funding for R&M phases of new developments	Other modification funds appropriated to support R&M, causing disruption and fluctuation of the modification budgeting process	Appropriation of other funds to support R&M can have a "ripple effect" on the funds allocation process, thereby affecting other programs.

Hierarchies were also formed for the key issues of business practices, requirements process, organization and training, and funding and budgeting, as shown in Figures 4-2 through 4-5. These five trees are not intended to represent the only ways in which the identified causes could be aggregated to form key issues. Alternate "slices" of the data could, for example, produce trees such as supportability, communications, policy, planning, and technical trees. Examination of the five trees developed reveals that

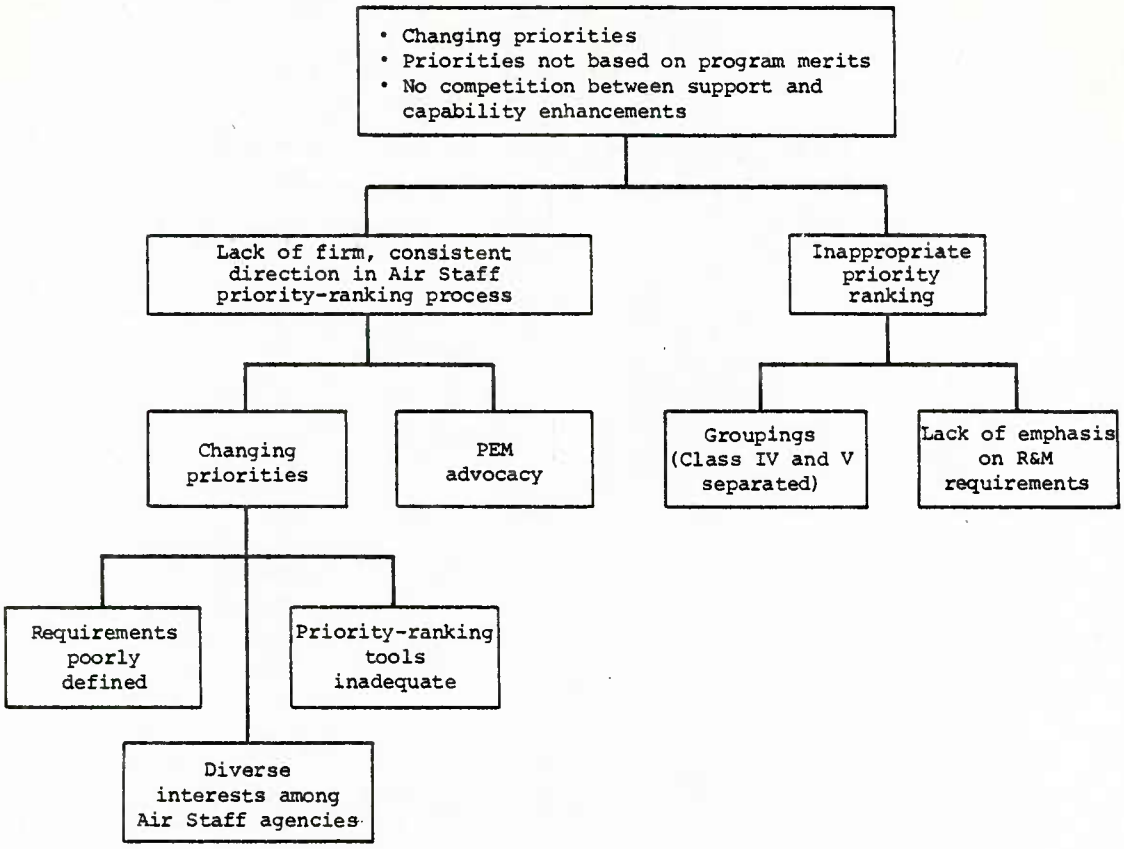

Figure 4-1. ALLOCATION-OF-RESOURCES HIERARCHY

the causes that would constitute these example trees are already distributed throughout the existing tree branches as individual elements or as sub-hierarchies. Alternative arrangements, not discussed here, may also be constructed. The intent was to aggregate the causes in a manner that would reduce the key issues to a manageable set and that would be based on the many sub-issues represented by the individual causes.

4.3 SUMMARY

The analysis presented here has resulted in the identification of five key issues related to the current aircraft modification management process. The basis for these issues are the results of the survey of the modification management community presented in Chapter Three. The number of key issues to be considered has been reduced considerably. It can be seen from examining the hierarchical trees that some problem causes have effects in several areas. The branches of these trees suggest that there are two or three alternatives for reducing the cost or timing impact of the contributing issues. In Chapter Five these key issues are integrated into an activity "road map" depicting a structured approach to their resolution.

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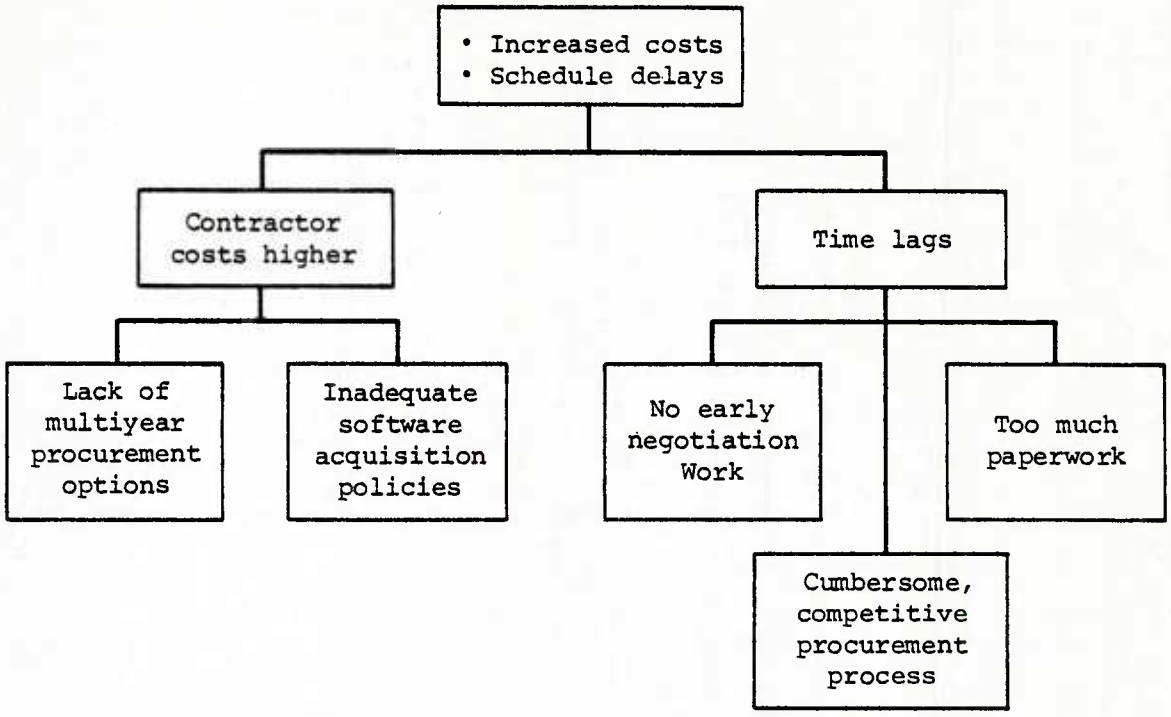

Figure 4-2. BUSINESS PRACTICES HIERARCHY

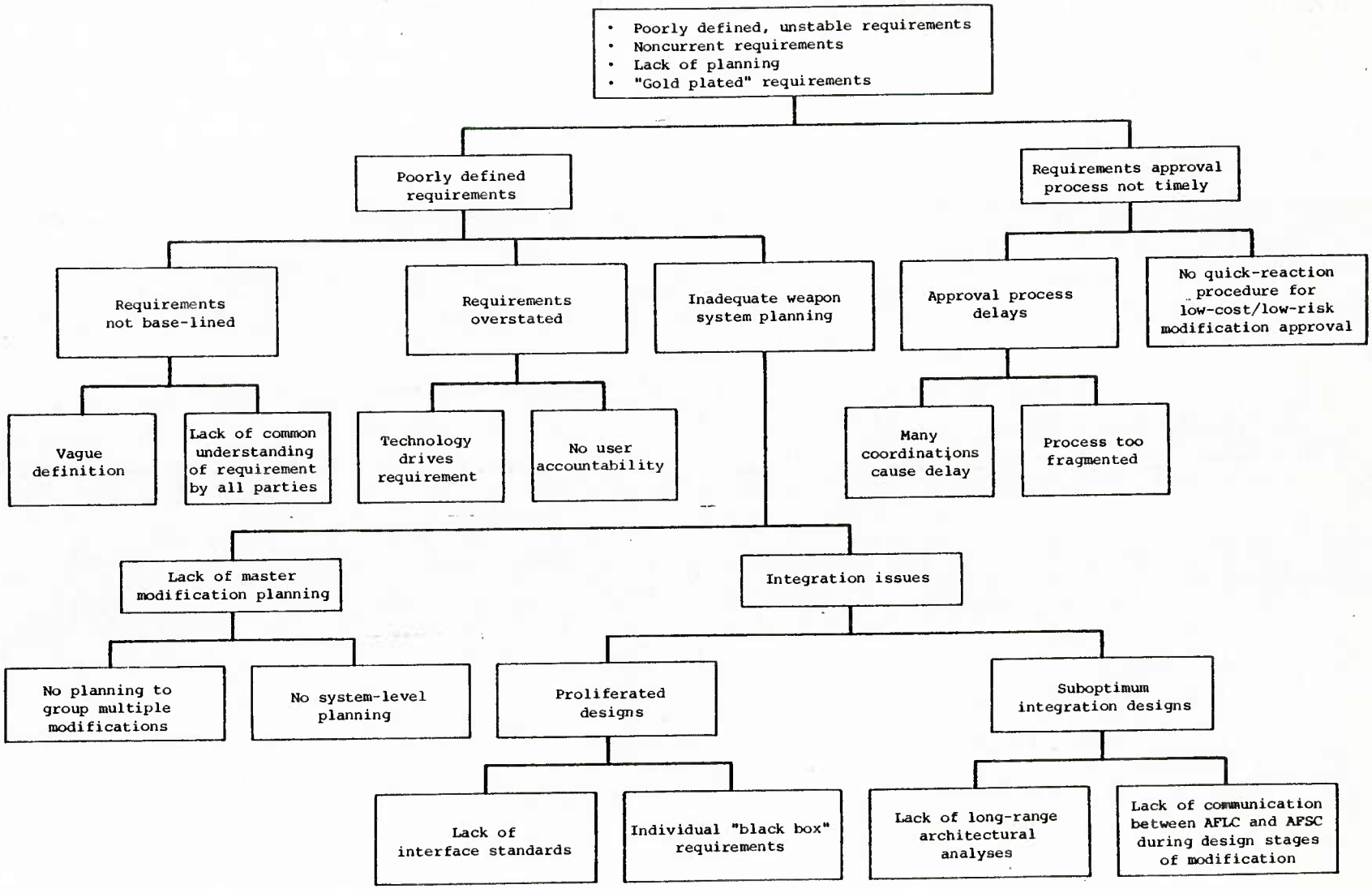

Figure 4-3. REQUIREMENTS PROCESS HIERARCHY

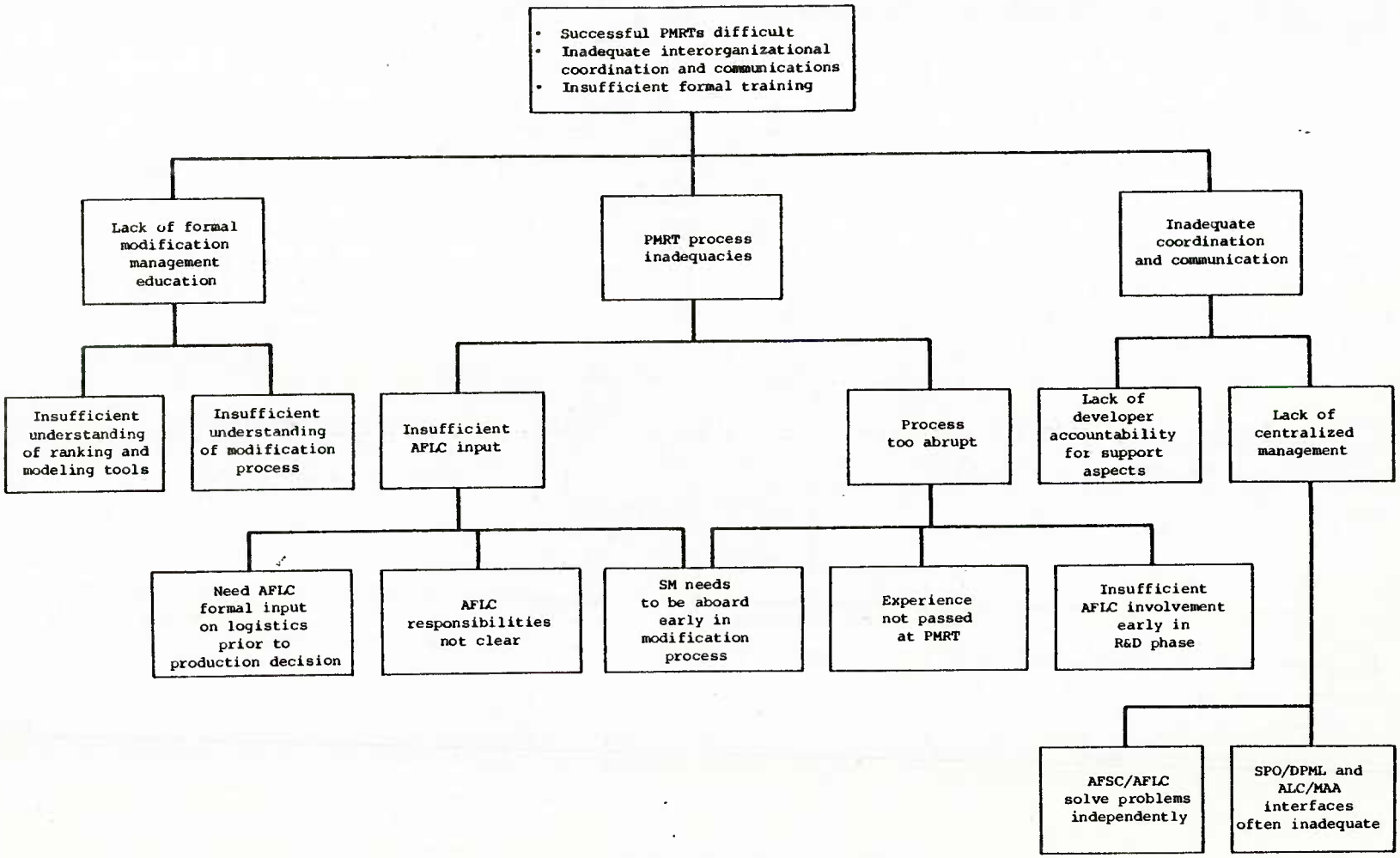

Figure 4-4. ORGANIZATION AND TRAINING HIERARCHY

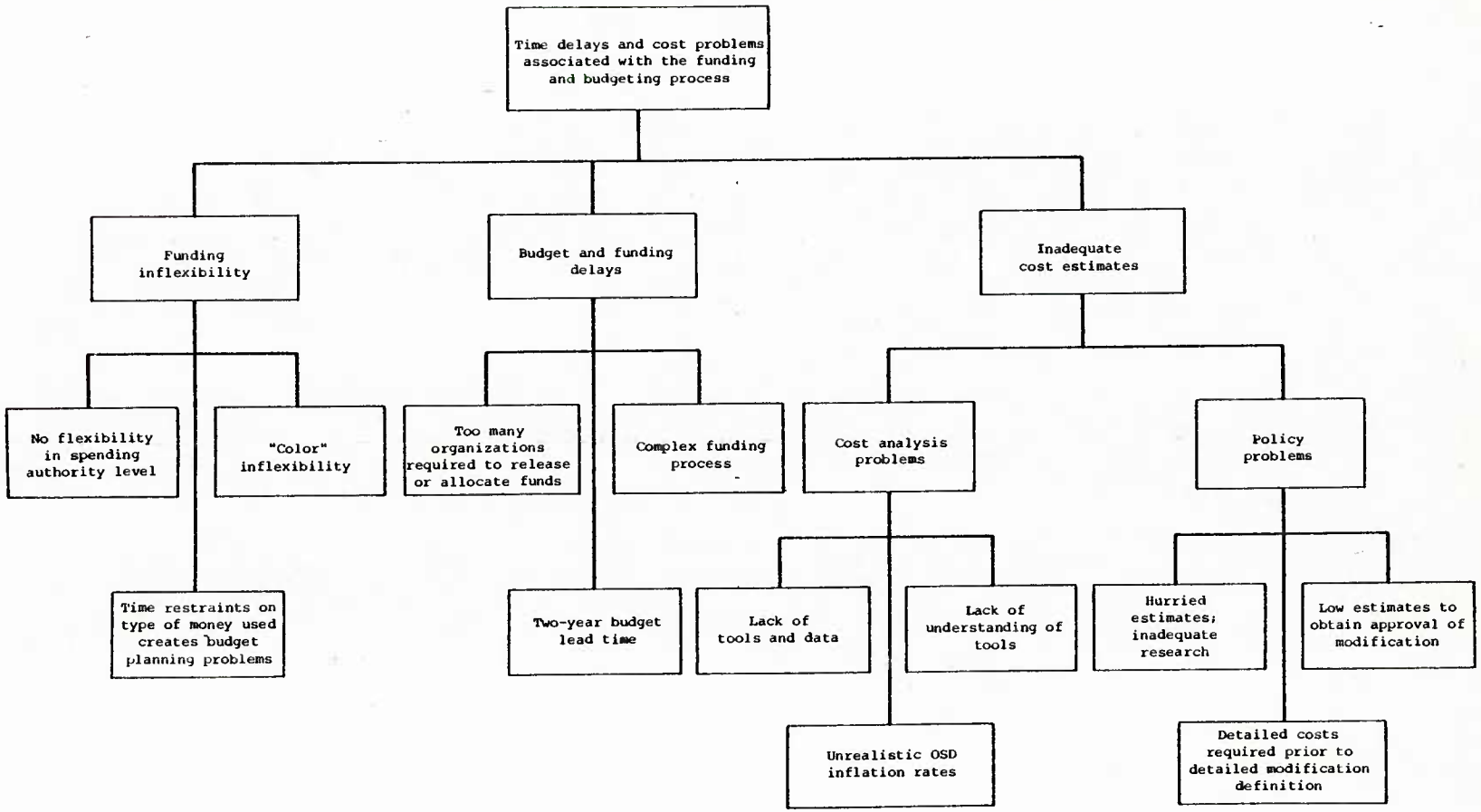

Figure 4-5. FUNDING AND BUDGETING HIERARCHY

CHAPTER FIVE

APPROACHES TO IMPROVE MODIFICATION MANAGEMENT PRACTICES

The present aircraft modification management process has evolved over many years, with numerous iterations and refinements. The process is well defined and logical; however, some practices occurring within the process framework have been questioned, since they adversely affect the acquisition of modifications to Air Force aircraft. This chapter outlines alternatives for improving the management practices in the aircraft modification process. These alternatives are presented in the form of a "road map" detailing a structured approach to the resolution of key issues identified in Chapter Four and are developed to assist the modification management community in its efforts to improve the Air Force modification process.

The alternatives presented in Section 4.2 were summarized in a single "road map" for implementation, illustrated in Figure 5-1. The overall objective, indicated at the terminus of the map, is to improve the management of modification programs. Numbered goals correspond to the key issues identified in Chapter Four. Each path identified by a Roman numeral presents the approach suggested by our analysis to reach the overall objective.

The upper left-hand entry point summarizes the existing organizational and policy framework for conducting modification programs. They key formal guidance describing the framework at this time includes:

- AFR 57-1, Statement of Operational Need, 14 June 1979
- AFR 57-4, Modification Program Approval, 15 December 1977
  - Change 1, 1 September 1978
  - Interim Message Change 79-1, 29 March 1979 (This change requires identification of the weapon systems to receive the Class V modification prior to FSED of the subsystem.)
- AFR 800-2, Acquisition Program Management, 14 November 1977
- AFR 800-4, Transfer of Program Management Responsibility, 10 March 1975
- AFLCR 57-21, Modification Program Approval, 12 April 1979

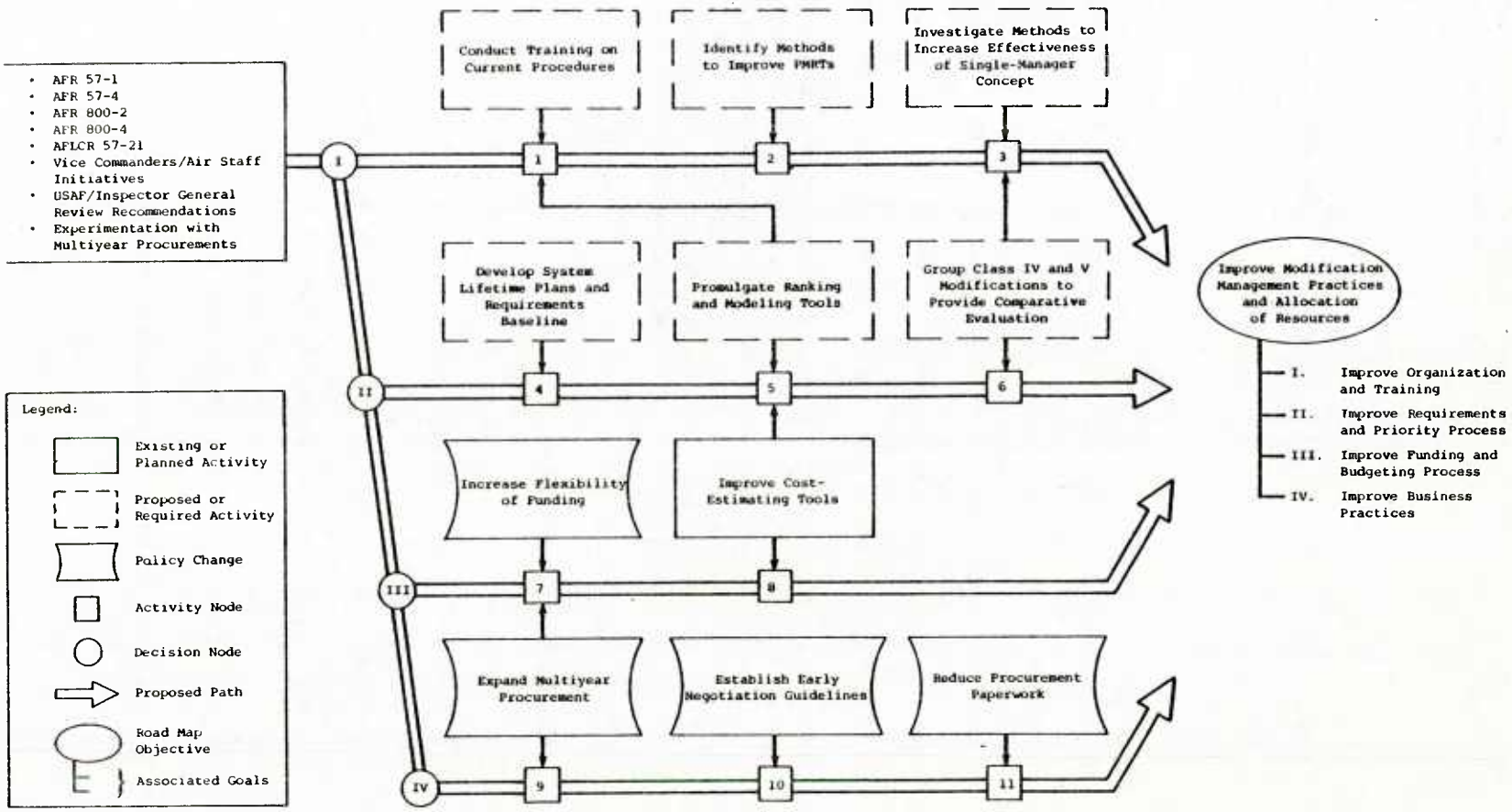

Figure 5-1. "ROAD MAP" OF MODIFICATION MANAGEMENT INITIATIVES

There are other pertinent DoD/USAF/MAJCOM formal guidance documents. The Klein and Smigel thesis* provides a complete listing of direction available for Class V modification management.

Other current activities include the initiatives associated with the Vice Commanders/Air Staff activity to formulate recommendations for improving the modification process. Master modification planning and other initiatives are beginning under the auspices of this group. AFR 57-4 has been completely rewritten and is currently being reviewed by the Air Force. In addition, the USAF/IG review recommendations are being implemented. These recommendations include:

- Independent cost estimates for modifications with certain dollar thresholds
- AFLC supportability acceptance prior to production decision

On the basis of the results of the analysis it was determined that the seemingly large number of issues surrounding aircraft modification management could be reduced to a relatively few when viewed from a cause-and-effect perspective. We found that there are four primary paths of action leading to improved management that could be followed in parallel or individually. Some of the required activities support the objective of more than one path.

The proposed alternatives were grouped by our perception of how they might contribute to one or more of the following four major paths:

- Path I could be implemented within the current policy framework. It would establish better training in current procedures, identify methods for improving PMRTs, investigate methods for increasing effectiveness of a single-manager concept, promulgate ranking and modeling tools, and group Class IV and V modifications to provide comparative priority ranking.
- Path II requires an active program of analysis and planning by the Air Force. Some activities in Path II are complementary to Path I. This path adds, in particular, development of system lifetime plans, together with a requirements baseline, to stabilize requirements for major aircraft weapon systems.
- Path III would require major planning and programming initiatives, to be implemented within DoD guidelines. These activities would be geared to investigating improved procedures and policies to increase the flexibility of funding modification programs and to expand the use of multiyear procurements.
- Path IV requires a combination of Air Force and DoD procurement regulation changes. In particular, methods, guidelines, and policies would be investigated to determine how to accomplish early negotiation efforts and how to reduce procurement paperwork.

*Barbara J. Klein and Michael A. Smigel, *An Acquisition Alternative: System Modification to Satisfy Mission Needs*, OTIC No. AD A076-823, Air Force Institute of Technology, 20 November 1979.

The initiatives presented in Figure 5-1 could be implemented as a comprehensive program or as separate initiatives in parallel. The activities are arranged in logical order, indicating those which serve multiple paths. A more detailed description of each activity is presented in Table 5-1.

The feasibility of each initiative must be assessed by the cognizant Air Force organizations. The purpose of this analysis is to present a perspective of the range of initiatives available to the Air Force so that the individual organizations can determine the contribution of their actions within the overall problem areas in modification management.

Table 5-1. ROAD MAP OF POSSIBLE IMPROVEMENT ACTIVITIES

Path ID	Node ID	Title	Description	Suggested Action Agencies
I	1	Conduct training on current procedures	This activity would be to develop a course of training for modification managers, including instruction on current formal guidance and all aspects of the modification management process.	USAF/RD/LE
	1	Promulgate ranking and modeling tools	Currently there is an insufficient understanding of available cost-estimating tools. These tools, as well as other ranking and modeling tools, must be made available and understandable to those who use them. This activity involves both training aspects of Path I and the priority process of Path II.	USAF/RD/LE
	2	Identify methods to improve PMRT	The interrelationships between development and logistics activities must be clearly defined so that program transitions between AFSC and AFLC can occur more smoothly to ensure that all system aspects are provided for adequately. This activity would involve identifying specific PMRT events that drive the transition and developing methods to improve their efficiency and effectiveness.	USAF/RD/LE
	3	Investigate methods to increase effectiveness of single-manager concept	Many of the problems associated with Class V modifications stem from unnecessary split management responsibilities. A single manager or program office to oversee the total program and accommodate differences between the developer and the implementer may be feasible. However, any single-manager arrangement must consider the nature of modification acquisition, requiring that the development activity and the support management function maintain its individuality. This activity would investigate the aspects of modification acquisition that might be combined to achieve the goals of each community.	USAF/RD/LE
	3	Group the Class IV and V modifications to provide comparative evaluation	Class IV and V modifications might be grouped so that modification programs directed toward reducing O&S costs versus increasing capability are compared on a common basis. Some of the ranking tools listed above must be developed further before this can be accomplished.	USAF/RD/LE
II	4	Develop system lifetime plans and requirements baseline	Modification master plans must be developed for each weapon system. The plan would identify the current weapon system configuration baseline, current modifications to the weapon system, and proposed modification or improved capabilities. These plans would be used to provide single-source documentation throughout all Air Force levels. The requirements baseline would be integrated into the lifetime plan to stabilize the requirements for a weapon system.	AFSC/AFLC
	5	Improve cost-estimating tools	Current cost estimates contain deficiencies and inaccuracies because of a lack of adequate cost-estimating tools, particularly for determining software and integration costs. These tools must be improved or new tools developed to improve the cost-estimating capability. OSD inflation factors have not been realistic and have led to low out-year cost estimates. Node 1 activity interfaces with this effort to ensure success and to avoid unnecessary duplication. This effort also contributes to the goal of Path III in the budgeting and funding process.	USAF/RD/LE
III	7	Increase flexibility of funding	System managers are constrained because of funding restrictions and need more authority to expend limited resources. Varying time constraints on the type of money used creates planning and budgeting problems. Authority is needed for full, multiyear funding of modifications. This activity would provide a policy review to determine where improvements in flexibility could be accomplished through restructured policies and procedures.	USAF/RD/LE
	7	Expand multiyear procurement	Authority and procedures are needed to negotiate up-front procurement options for multiyear procurements with inflation factors built in. This would contribute to Path III and IV goals.	AFSC/AFLC
IV	10	Establish early negotiation guidelines	Authority is needed to commence procurement negotiations as soon as "front end" or initial requirements are known to both parties, but prior to completion of all paperwork for funding authorization. This activity would review and assess the negotiation process to determine where policy and procedure changes could contribute to more effective business practices.	AFSC/AFLC
	11	Reduce procurement paperwork	There is a need to streamline the procurement process. Currently, the bureaucracy and paperwork associated with the procurement and legal processes tend to delay the acquisition of modifications. Areas of efficiency should be determined and appropriate policies and guidelines developed to accomplish the reduction of unnecessary administrative burden and paperwork.	AFSC/AFLC

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

The Air Force is pursuing an aggressive modernization program to maintain the force structure at a high level of operational readiness. In addition, rapidly expanding technology is being exploited to maintain a high degree of capability in an aging force. These factors are expected to result in an extensive aircraft retrofit program at least through the year 2000.

The objectives of this study effort were (1) to identify, define, and validate the most significant problem areas in aircraft modification management; (2) to examine the causes and effects of identified problems and develop a structured approach to their resolution; and (3) to identify areas requiring research and initiatives leading to improvement in aircraft modification management.

6.1 CONCLUSIONS

Improvement alternatives to the current modification management practices can be categorized into four major areas:

- Improvements to Organization and Training. These actions could be implemented within the current policy framework. Possible initiatives would be to establish better training on current procedures, identify methods for improving PMRTs, investigate methods for increasing effectiveness of a single-manager concept, promulgate ranking and modeling tools, and group Class IV and Class V modifications to provide comparative evaluation.
- Improvements to Requirements Definition and Priority Ranking. These actions would require an active program of analysis and planning by the Air Force for the development of system lifetime plans, together with a requirements baseline, to stabilize requirements for major aircraft weapon systems.
- Improvements to Funding, Budgeting, and Programming Linkage. These actions would require major planning and programming initiatives but could be implemented within Air Force PPBS control. Activities might be geared to investigating improved procedures and policies to increase the flexibility of funding modification programs and to expand the use of multiyear procurements.

- Improvements to Business Practices. These actions would require a combination of changes to Air Force and DoD procurement regulations. In particular, methods, guidelines, and policies would be investigated to determine how to accomplish early negotiation efforts and how to reduce procurement paperwork.

The initiatives identified could be implemented as a comprehensive program or as separate initiatives in parallel. We have arranged the activities in logical order, indicating those which serve multiple paths.

6.2 RECOMMENDATIONS

We recognize that solutions to many of the issues discussed can be quite complex because of institutional preferences, organizational inertia, and availability of resources; therefore, it appears that implementation of the structured "road map" approach requires dedicated sponsorship and determination for successful completion. The steps that are easiest to achieve should be initiated first; those which are more difficult at later dates. In keeping with this general philosophy, ARINC Research recommends that the Business Management Center take the following actions:

- Coordinate the results of this study with other current Air Force efforts to improve modification management.
- Discuss initiatives with cognizant Air Force organizations (1) to determine the feasibility of implementing various activities, (2) to designate responsible parties, and (3) to agree on charter areas.
- Selectively undertake or sponsor those activities which are institutionally achievable within current available resources. Plan for implementation of subsequent activities for which agreements can be reached.

APPENDIX A

REFERENCES AND BIBLIOGRAPHY

This appendix lists the references used in the study effort and a bibliography.

1. Bagley, Larry, *F-4E Advanced Avionics Integration Program: Lessons Learned,* Defense Logistics Studies Information Exchange (DLSIE) No. LD 42133A, Air Command and Staff College, Maxwell AFB, Alabama, May 1978. This paper describes the F-4E Advanced Avionics Integration Program (AAIP). It focuses on the management problems encountered during the program, with particular emphasis on the management lessons learned that are applicable to future aircraft modification integration. It also describes the AAIP improved coordination between the subsystem program offices, identified interface and hardware deficiencies, and improved overall and individual system capabilities.

2. Balven, Terry L., *Acquisition of Class V Modifications (Projects 77-23 through 77-27),* AFALD/AQI, Wright-Patterson AFB, Ohio, 16 February 1979. This final report describes five AFALD/AQI projects established as elements of an overall effort intended to improve the acquisition of new capabilities as Class V modifications. The five projects are Class V Modification Planning Guidance, System Management Responsibilities in Class V Modifications, Integration of Concurrent Class V Modifications, Planning and Scheduling of Modifications, and Approval and Direction of Class V Modifications. The projects deal with 11 issues that were frequently addressed in an earlier project to identify deficiencies or problems in the acquisition of modifications. Included in the report is a discussion, conclusion, and recommendation for each of the issues, as well as an overall conclusion and proposed solution for greater participation of the system manager in the development phase of planning for the fulfillment of an Air Force requirement.

3. Bryant, Herbert G., *Program Manager in AFLC,* DLSIE No. LD 32636A, Defense Systems Management College, Fort Belvoir, Virginia, May 1974. The modification program in the USAF is big business. It affects major weapon systems and DoD budgeting, planning, and execution. It is subject to Congressional scrutiny and criticism. The Air Force has a clear and well defined modification program. Major problem areas are decisions (1) to modify or by new systems, (2) in design and development of modification kits, (3) in proof of modification capability, (4) in use of kit inventory, and (5) in training of capable modification managers. The writer recommends that these problem areas be addressed by the Air Force to better manage its modification program.

4. Bush, Don G., *An Analysis of Modification Development Through Material Improvement Projects,* Defense Technical Information Center (DTIC) No. AD 892 682, The School of Systems and Logistics, Wright-Patterson AFB, Ohio, August 1971. The objectives of this thesis were: (1) to identify and describe the present procedures for developing Class IV modifications, (2) to determine the time required to complete each step of the material improvement project (MIP) process, (3) to determine whether the time currently taken in each step of the MIP process is necessary, and (4) to suggest new or revised procedures that will expedite MIP processing. The

following questions were used to guide the research toward accomplishing stated objectives: (1) What are the present procedures for developing Class IV modifications? (2) What are the times required to complete each step of the MIP process? (3) Is the time currently taken in each step of the MIP process necessary? (4) What new or revised procedures will expedite MIP processing? The author concludes with findings and recommendations resulting from the research effort.

5. Cilvik, Reginald M., *Class V Modification Management and Planning: A Guide for the AFSC Program Manager of Less-Than-Major Systems,* DTIC No. AD A042 941, Defense Systems Management College, Fort Belvoir, Virginia, May 1977. The primary goal of the report is to provide the AFSC program manager of less-than-major systems with an understanding of the importance of the early planning interface required among the AFSC PM, AFLC agencies, and higher headquarters and the impact of the PM in the implementation of Class V modifications. A summary is presented of the current DoD and Air Force documentation that provides data for basic authority and establishes policies for Class V modifications. Outlined are typical interfaces between the AFSC program office, AFLC agencies, and HQ USAF required for AFLC-managed Class V modifications. A brief overview is presented of the DoD Planning Programming, and Budget System (PPBS), which illustrates the importance of lead timing for the modification budget submission within PPBS. The different procurement appropriations, Class V modification budget program monies, and planning documentation are summarized. Problem areas in modification management are discussed on the basis of interviews with AFSC and AFLC personnel. General guidelines are established to assist the AFSC PM to accomplish his program more effectively through better understanding of the Class V modification process. Such improved understanding should facilitate the transition from an RDT&E program to a Class V modificiation program.

6. Coleman, Charlie J. Jr. and Edison, Thomas R., *Development of a Systematic Technique for Analyzing the Effectiveness of Aircraft Class IV Modifications,* DTIC No. AD A-6-551, The School of Systems and Logistics, Wright-Patterson AFB, Ohio, September 1978. Data from the Air Force maintenance requirements data system (G098) were used to develop an assessment technique through parametric and nonparametric statistical mean difference tests to evaluate the effectiveness of Class IV modifications. Fourteen selected modifications were evaluated to demonstrate how the G098 data were compiled and analyzed by this technique. Included in this evaluation were data on maintenance actions, man-hours, NORM, NORS, and failures before and after the modification. These data sets were adjusted for variations in flying hours and sorties. These data were then analyzed to determine if there were any significant improvements as a result of the Class IV modification.

7. Gardetto, B.A. Jr., *Logistics Support of Class IV and Class V Modification -- Summary Report of Audit,* DLSIE No. LD 39648A, Air Force Audit Agency, Norton AFB, California, January 1977. Modifications are changes in the physical configuration or functional characteristics of a weapon system or piece of equipment. Most modifications accomplished in the Air Force are Class IV and Class V. Class IV modifications are designed to improve safety conditions, correct equipment deficiencies, or improve logistics support. Class V modifications are changes to a weapon system or an item of equipment intended to provide a new or improved operational capability or to remove an existing capability that is no longer required. This audit was conducted to evaluate the effectiveness of policies, procedures, and controls employed in the logistics support of Class IV and Class V modifications.

8. Gordon, Robert J., *A Suggested Improvement to Precontractual Activity for Aircraft Modifications,* DLSIE No. LD 28982, Air War College, Maxwell AFB, Alabama, March 1973. The modification of existing aircraft, as opposed to the procurement of new aircraft, is unique in two ways. The type of competition existing in industry is different, because usually, but certainly not always, the manufacturer of the aircraft or subsystem to be modified has an "edge" over his competition. In addition, the degree of impact on the aircraft using and supporting activities is a large variable and is not necessarily directly proportional to the extent or cost of the modification itself. The cost is often larger than the cost of the modification by itself, which is not the case when fielding a new aircraft weapon system. This report presents suggestions to better take advantage of these two unique aspects by enhancing real contractor competition and providing a more cost-effective implementation of the modification. These suggestions can be implemented without change to existing laws and regulations.

9. Haslam, Donald E. and Berger, Calvin C., *Evaluation of Management Responsibilities in the Air Force Aircraft Modification Program,* DTIC No. 769 118, The School of Systems and Logistics, Wright-Patterson AFB, Ohio, August 1973. The U.S. Air Force must conduct a continuing aircraft modification program to maintain a safe and combat-ready aircraft fleet. This large modification program necessitates an intricate management structure to review, approve, coordinate, and implement the total program. There is evidence to indicate that misunderstandings of organizational responsibilities exist, resulting in frequent deviations from established procedures. This causes program cost growth, stretch-outs, delays, improper decisions, and other time-consuming and expensive problems. This study was intended to determine if misunderstandings of assigned responsibilities exist in the management of the Air Force aircraft modification program.

10. Klein, Barbara J. and Smigel, Michael A., *An Acquisition Alternative; System Modification to Satisfy Mission Needs,* DTIC No. AD

A076 823, Air Force Institute of Technology, 20 November 1979. The process of acquiring major military weapon systems to satisfy defense mission needs has become increasingly complex, costly, and time-consuming. Modification of existing systems to add new capabilities is currently viewed as an alternative process to new-weapon-system acquisition for Air Force modernization requirements. The study reviewed this alternative process as it exists today by addressing three objectives: (1) to develop a current annotated bibliography of studies and guidance for Class V modification management, (2) to identify and compare existing models that have been developed to describe the modification management process, and (3) to identify outstanding issues and problems in the area of managing Class V modifications that are considered important by the managers. The first two objectives were accomplished and presented as a result of an extensive literature search. Managers of current modification programs categorized as Class V, defined as major, and involving four USAF weapon systems were interviewed for reactions to possible problems and for comments on existing issues. Interview results were presented and analyzed, and on the basis of the findings, the researchers offered conclusions and suggestions for further research.

11. Lavoie, Robert P., *A Faster Response to Threat Changes and User Requirements,* unpublished research paper, Report No. 392, Air War College, Maxwell AFB, Alabama, April 1978. This research paper reviews three major, high-level assessments of the R&D process (1956 to 1977) to set the background for a "bottom up" look at the lengthy, reactive process that responds to threat changes or new mission requirements long after they are confirmed. It is the opinion of the complex management environment that the existing policies and procedures may not be the driving factors in this process, specifically with respect to the modification and modernization programs. Organizational and administrative changes and the adoption of a fundamental investment strategy are proposed. The new decision process would include consideration of minor and major modification activity during the system's life.

12. MacIssac, Richard S., *A Guide for the AFLC Program Manager of Major Production Class IV and V Modifications,* DTIC No. AD A077 673, The School of Systems and Logistics, Wright-Patterson AFB, Ohio, September 1979. The purpose of this study was to provide a guide for the Air Force Logistics Command's program managers that would bridge the gap between kit and major new-weapon-systems management. It describes the modification proposal and approval process, identifies DoD directives and policies that affect modification management, and provides "lessons learned" from past and present major production modifications.

13. Malkiewicz, Albert F., et al., *An Investigation of Cost Factors Relating to Class IV Aircraft Modifications,* DTIC No. AD 769 195, The School of System and Logistics, Wright-Patterson AFB, Ohio,

August 1973. The emphasis on economic use of resources and the necessity to justify and account for each dollar spent has required more research into the methods of collecting costs of public programs. Aircraft modifications have been the subject of increasing concern, and the Air Force has been criticized for not being able to identify all costs of an aircraft modification. The research conducted for this effort was to determine the significant costs involved in Class IV aircraft modifications and which of these have been included in modification approval procedures. Current modification processing procedures have been described to understand how costs have been collected.

14. Meyette, Ronald J., *Lead Time Away Procurement of Modification Kits,* DLSIE No. LD 33023A, Defense Systems Management College, Fort Belvoir, Virginia, November 1974. This paper presents the results of a study to determine (1) why the Air Force bought modification kits under a "lead time away" policy, and (2) were the Army and the Navy buying modification kits in the same manner. The lead time away policy restricts the services from buying modification kits in the current year if they cannot install them in the following year. This means that if a particular aircraft model (e.g., F-111, C-5A) is scheduled to receive a modification when it goes through depot-level maintenance and the depot cycle is five years, then the services must buy modification kits four or five times instead of once. The report (1) describes Air Force depot-level modification program responsibilities and schedules, (2) defines the Air Force lead time away concept and identifies applicable regulations, and (3) describes the implementation of the lead time away concept in the Air Force.

15. Milliken, W.R., *Class V Modifications: Problems in Improving Existing Weapon Systems and Equipment,* DLSIE No. LD 42321A, Air Command and Staff College, Maxwell AFB, Alabama, May 1978. The Air Force Class V modification process is used to modify existing weapon systems and equipment instead of procuring totally new systems to provide new or improved capabilities. The modifications entering the current and future inventory are vital instruments in our national security posture. The effectiveness of these programs is directly affected by our current management and development process. This research study develops a typical sequence of events describing the Class V modification process. Specific problems that have been encountered in Class V modification developments are used to identify process deficiencies. Recommendations are provided to improve the overall effectiveness of the process.

16. Ring, Henry A. and Robinson, James A., *A Method of Estimating Class IV Modification Costs for Fighter Aircraft,* DLSIE No. LD 24527, Air Force Logistics Command, Wright-Patterson AFB, Ohio, January 1970. This paper reports the results of a fighter aircraft modification cost study, which was undertaken to develop a better method of predicting modification costs for proposed fighter

aircraft. A data base of eight fighters currently in the Air Force inventory was selected for the study. The inventory value and the modification costs associated with each fighter were collected by fiscal year and adjusted to a common-year base for trend analysis and for the computation of a composite fighter factor. The method of least squares was used to develop an estimating equation for the prediction of annual modification costs of new fighters. The estimator can use the equation by knowing the estimated flyaway cost of the proposed fighter and the aircraft quantities that will be on hand during each year.

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18. U.S. Air Force, AFR 57-1, *Statement of Operational Need (SON),* 12 June 1979. AFR 57-1 states Air Force policy for developing, documenting, and processing statements of operational need and system operational concepts. These policy statements apply from the identification of need and deficiencies through the entire acquisition life cycle. Validated statements of operational need provide the justification for the initiation and continuation of systems and equipment development, acquisition, and modification. This regulation, together with AFR 800-2 and AFR 70-15, implement portions of DoD Directive 5000.1, Major System Acquisition, 18 January 1977 and Directive 5000.2, Major System Acquisition Process, 18 January 1977.

19. U.S. Air Force, AFR 57-4 (C1), *Modification Program Approval,* 15 December 1977, (C1) 1 September 1978, Interim Message Change 79-1, 29 March 1979. AFR 57-4 describes the procedures for planning, documenting, and obtaining approval of a modification. It applies to the processing of modification requirements for all Air Force, Air Force Reserve, and Security Assistance activities for which the Air Force has logistic support responsibility. It implements those configuration control portions of AFR 65-3 which pertain to modifications and prescribes the Air Force forms for Class V modifications to replace MAJCOM forms. Interim Message Change 79-1 requires identification of the weapon system to receive the Class V modification prior to FSED of the subsystems. A total draft rewrite of AFR 57-4 is currently in Air Force review.

20. U.S. Air Force, AFR 65-3, *Configuration Management,* 1 July 1974. AFR 65-3 prescribes uniform policies and guidance for the military services and defense agencies responsible for implementation of configuration management.

21. U.S. Air Force, AFR 172-14, *Full Funding of Air Force Procurement Programs,* 6 July 1978. AFR-172-14 prescribes the full funding concept for the Air Force procurement programs. It applies exclusively to Air Force procurement appropriations and to the budget and procurement activities of Headquarters USAF, AFLC, AFSC, and the USAF Security Service. It implements DoDD 7200.4, which describes the full funding concept.

22. U.S. Air Force, AFR 800-2, *Acquisition Program Management,* 14 November 1977. AFR-800-2 states the policy for managing all Air Force acquisition and modification programs that are funded either through procurement appropriations or through the Development, Test and Evaluation (RDT&E) appropriation. It implements DoDDs 5000.1 and 5000.2. It requires that "all persons involved in acquisition programs must comply with this regulation," provides general delegation of management responsibilities, and explains DoD and Air Force terminology.

23. U.S. Air Force, AFR 800-4, *Transfer of Program Management Responsibility,* 10 March 1975. AFR 800-4 provides for the transfer from an implementing command to a supporting command. It provides specific AFSC/AFLC PMRT guidance and the Coordinated PMRT Plan for systems and equipment. For Class IV and V modifications, and other programs in which AFLC is initially designated as the implementing command and AFSC has engineering or other responsibility, a limited PMRT agreement is required.

24. U.S. Air Force, AFP 172-4, *The Air Force Budget,* 1979. AFP 172-4, published by the Comptroller of the Air Force, describes the Federal, DoD, and Air Force budget systems. It discusses the planning, programming, and budgeting system (PPBS); the budget formulation process; the Congressional budget process; and budget execution.

25. U.S. Air Force, AFLCR 57-21, *Modification Program Approval,* 12 April 1979. AFLCR 57-21 establishes policies and procedures for the documentation, processing, and approval of modification requirements following transfer of program management responsibility from AFSC to AFLC. It outlines AFLC responsibilities in support of AFSC-managed updating changes and Class V modifications before program management responsibility transfer. This regulation implements AFR 57-4 and applies to AFALD, AGMC, and all ALCs.

26. U.S. Air Force, AFLC/AFSC Pamphlet 800-34, *Acquisition Logistics Management* (Draft). AFLC/AFSC Pamphlet 800-34 serves as a basic reference document for acquisition logistics matters within AFLC

and AFSC. It is intended to assist primarily the program manager and the Integrated Logistics Support Office (ILSO) in identifying, scheduling, and accomplishing, or causing to be accomplished, the key logistics tasks necessary for the logistics support of acquisition programs. It is also intended to provide guidance and information that will assist other organizations within the program office and AFLC/AFSC field activities in understanding the role of the ILSO, as well as their roles in the ILSO's functions and responsibilities.

27. U.S. General Accounting Office, *Management of Aircraft Modification Programs in the Army, Navy, and Air Force,* Department of Defense, DLSIE No. LD 32042A, October 1974. The Army, Navy, and Air Force had an aircraft modification workload of more than 55 million man-hours outstanding in July 1970. The authorization and appropriation committees of the Congress expressed concern about this and the services' ability to manage any additional modification work effectively. This report measures the extent to which the services have reduced the backlog and evaluates the services' management of the modification programs.

APPENDIX B

QUESTIONNAIRE DISTRIBUTION LIST, PERSONNEL INTERVIEWED, AND SURVEY COMMENTS

This appendix contains the questionnaire distribution list, the number of personnel interviewed at each organization, and the survey comments received from each organization.

QUESTIONNAIRE DISTRIBUTION LIST

HQ AFSC/CV/CS/XR/SD/PM/LG/TE/SDO/SDX/SDD/SDDL/SDDS/SDDE/SDNF/SDZ

HQ USAF/RDPV/RDQA/RDQT/RDQM/XOX/XOXF/XOO/XOOJ/XOOTT/LEX/LEXW/LEYY/LEYYC/CVAX

HQ TAC/CV/DR/DO/XP/LG/LGM/LGMD/DRA/DRP/II

HQ SAC/CV/XPH/LGM

HQ MAC/CV/XPH/LGM/LGMW

HQ AFLC/CV/XR/LO/LOA/LOW

HQ AFALD/CC/CV/SD/SD-16/PTE

OO-ALC/MM/MMM/MMS

HQ SD/AQL

HQ AD/CZ/XR/SD/SDES

HQ ESD/XR/DCY/DCB

HQ ASD/AX/XR/YP/YPC

HQ ATC/CV/LG/XP/XPQ

HQ USAFE/CV/XPH/LGM/DOQ

HQ PACAF/CV/LGM/DOOQ

WR-ALC/MM/MMM/MMS

SA-ALC/MM

OC-ALC/MM

SM-ALC/MM

HQ AFTEC/LGM/LGL

Personnel Interviewed

Organization	Number of Personnel
HQ USAF	4
HQ AFLC	2
Warner Robins ALC	3
Ogden ALC	3
HQ AFSC	4
AFSC/ASD	1
AFALD	1
Total	18

SURVEY COMMENTS

The following edited listing presents the significant comments received resulting from the survey of the modification management community. The list includes comments received in response to the mailed questionnaire as well as those obtained during discussions with key organizations and individuals. The comments have been edited and in some cases paraphrased for clarity and brevity. Comments in which the substance has been duplicated by more than one respondent have been combined. These comments are arranged to correspond with the mailed questionnaire. Within each question the list is organized into logical subgroups determined by the nature of the comments.

Question 1: Modification Requirements Definition

A. Vague, poorly defined requirements, floating requirements baseline

- User requirements are purposely vague in order to permit "pushing" for latest technology and capability; logistics support always suffers.
- Most requirements are poorly defined logistically.
- A design baseline is difficult to achieve and typically "floats" through the entire development cycle, causing cost increases, schedule slips, and logistics impact in that the support package lags the system because of late design fixes.
- The real need is often clouded; the requirement is almost always exaggerated.
- Frequently, requirements are too broad and too optimistic.

B. Lack of total weapon system considerations

- There is a lack of total system harmony of requirements that takes into account all aspects of existing and add-on systems to a common baseline reference for all sensors, weapons, etc.
- No systems look at mission capabilities.
- Treated individually, requirements cause engineering repeats.
- Specific modifications may be well defined, but there are too many initiators; therefore, the total weapon system's modification requirements are poorly defined.
- Modifications usually do not consider pilot ease of operation or system flexibility and utility with other systems on the aircraft; i.e., integration is not emphasized.

C. Lack of coordination and common understanding of requirement

- Requirements become poorly defined because of a lack of coordination in the early phases of development between the hardware developer and the SM or SPO.
- Requirements are not mutually understood by the user, developer, and contractor.

D. Technology drives requirements

- In many cases, requirements are "sold" on the basis of an existing technical capability rather than being generated through the MAA process.
- Technology is driving many requirements. Advocacy is often too much of a factor.

E. Currency of definition

- The long time period between requirements definition and program implementation works against the currency of requirements.

F. Class IV R&M requirements

- There is a problem in identifying, justifying, and funding Class IV R&M modification requirements. Operating commands pay dearly for this in terms of maintenance costs and downtimes.

G. User accountability

- User has no accountability for requirements he generates.
- Users are not aware of funding constraints. They should gear their requirements to levels of capability at various funding levels and describe what the options are and what is the minimum acceptable capability to address the requirement.

Question 2: Timeliness of the Modification Requirements Process

A. Budgeting, funding, and procurement delays

- A significant source of delay is attributed to the two years required to obtain Class IV modification funding.
- The Class IV modification funding time (e.g., budget, Form 775) is unrealistically long.
- There is resistance in procurement to do any front-end work before having funds committed.
- The budget process necessitates that the requirement lead the funding by at least two years before it is introduced into the POM.

- Funding constraints cause inability to adequately relate requirements versus time. Resulting delays disrupt orderly operational requirements planning.
- A problem exists with budget exercise timing between various organizations in the Air Force POM (i.e., AFSC later than Air Staff).
- Funding time constraints lengthen process.
- Primary source of delays is procurement bureaucracy and legal entanglements.
- Competitive procurement requirements lengthen the process so that modifications are no longer state of the art when implemented.

B. Modification approval process delays

- CCB process is too slow; simplified procedures are needed.
- A better system of identifying modification requirements is needed. For the user the process takes too long; for the engineer there is too little time before the requirement is firmly defined.
- Decision process takes too long by users and approvers.
- Frequently the analysis phase takes longer than the modifications they are intended to support.
- A source of significant delay is AFLC and HQ USAF changes to Form 48 that require coordination with all parties. It is believed, however, that all parties must be involved.

C. Simplified low-cost/low-risk modification procedures

- Class V SON preparation time for low-cost/low-risk modifications should be reduced.
- For simple modifications, it sometimes takes two years of staffing before implementation. There is a need for a "quick response/action" modification agency for these relatively simple modifications.

D. Fragmented management authority

- The process is too fragmented; the system manager must be in control of requirements definition for his system.
- There is no single-point manager with a master plan that would eliminate the need for numerous crosschecks.

Question 3: Criteria for Modification Priorities

A. Inadequate tools or figures of merit

- Technical tools are needed to enhance ability for priority-ranking modifications in terms of cost and MAA benefits.
- Measure of merit should tie directly to mission success.
- There are currently no significant figures of merit to quantify impact of proposed modifications on force readiness.
- Both operational and cost factors should be included. In many cases unrealistic operational requirements drive up the cost without adequate justification.
- Occasionally operational factors may dictate other than the most cost-effective solution.

B. Inappropriate organization of priority groupings

- Class IV and Class V modifications should be priority-ranked; segregation should be by weapon system.
- The value of modifications should play against other programs on a weapon system or MAA basis as an improvement to that system's readiness; therefore, programs aimed at increasing operating hours versus those aimed at increasing capability are compared on a common basis (multiple aircraft programs and Class IV A modifications would probably be excepted).
- For smaller programs, keep R&D and modification funds dedicated by mission area (major programs are already priority-ranked by mission area via VANGUARD and POM).
- Small, low-cost modification approval should rest with the system manager.

C. Priority-ranking criteria/process too unstructured

- Class V priority-ranking process seems weak. Frequently there is no apparent reason for approval of some modifications and disapproval of others.
- System managers are not always familiar enough with problems to assign priorities.
- Class IV C modifications (logistics enhancements) do not always obtain approval.
- Frequently, political persuasion wins out -- more structured priority-ranking criteria are needed.
- Occasionally, Class IV A (safety) classification is misused because it is easier to obtain funds under this classification.

Question 4: Hardware Development and Hardware Implementation as Separate and Distinct Activities

A. PMRT process lacking

- PMRT should be considered from inception, and AFLC interface should be maintained through the SPO to ensure consideration of implementation factors.
- PMRT process is ineffective in that not enough interaction occurs between AFLC and AFSC to effect a smooth transition.
- PMRT should be more gradual. AFLC must become involved earlier in R&D programs to avoid inheriting unmanageable modification programs.
- PMRT responsibility for AFLC frequently is not clearly defined.
- Experience is not passed on at PMRT.
- System manager needs to be involved early in the program.
- AFLC needs stronger voice prior to PMRT.
- In theory, the PMRT process is all right; however, as it works today, it is a step function -- it needs to be smoother and more gradual in transition.

B. Inadequate communication and coordination between AFLC and AFSC

- There is a lack of communication between AFLC and AFSC during the design stages of the modification process.
- More AFLC input is needed in the decision-making before transfer and further implementation.
- There must be closer coordination between AFSC and AFLC during all stages of the modification effort.
- The system manager should monitor AFSC development to ensure compatibility of equipment to aircraft.
- Liaison is essential between AFSC, AFLC, and users.
- The acquisition division (MMA) at the ALCs is not functioning properly.
- There is not enough operating and logistics management within SPOs at the working levels and in the program offices. Smaller programs do not get enough management.
- Often, AFLC solves problems in a vacuum, i.e., buys more spares without the knowledge that the end item of interest is being changed and those spares are essentially "white elephants."

C. Developers insensitive to support aspects

- Developers are not aware of R&M requirements.

- Developers are cost- and schedule-driven; if cost or schedule becomes critical, reliability gets compromised.
- Developers usually trade off R&M aspects for capability.
- Because developers do not have responsibility for life-cycle support aspects of Class V modifications, they are not motivated to address this adequately during development. ALD and DPMLs should be "watchdogs" of support aspects.

D. No single management authority

- A single integrator is needed -- SPO before PMRT and SM after.
- Development and implementation are separate and distinct; however, one command should have overall modification management responsibility.
- Development and implementation cannot be managed independently. A single office responsible for the whole effort is required, because each side (AFSC, AFLC) is concerned with different aspects of the effort.
- There is a need for combined development and implementation management, such as a program office, to oversee both AFLC and AFSC working-level activities in a program or weapon-system lifetime SPO arrangement.
- A modification "czar" is needed with backing by AF/CC.
- The developer should be contracted to the support agency.

Question 5: Modification Management Function at the Air Staff Level

A. Inadequate evaluation of modification requirements

- Air Staff is too far removed from the weapon system to understand the technical requirement.
- Requirements may be validated on the availability of funds.
- Air Staff often does not adequately consider the total requirement.
- Many times the outcome of a program is determined by the PEM and which "pot" has funds to accomplish a given effort.

B. Inefficient or inappropriate staffing processes and organization

- Programs move on the basis of how dynamic the PEM is rather than on the program's own merits.
- PEMs get pressured by commands.
- PEMs often do not adequately consider logistics support aspects.
- PEM advocacy distorts objectivity.

- PEMs have too many programs or for other reasons do not get involved in enough details to provide good guidance to the field.
- Air Staff internal communications need improvement.
- Air Staff organization should be along functional lines.
- Too much of the modification planning process is performed by funds managers.
- Cost-effectiveness trade-offs are inadequately evaluated in the face of constrained budgets.
- The Air Staff process often creates excessive delays in modification processing.
- There is a need to develop a more coordinated process.
- F-111 computer replacement is a prime example of where Air Staff, as well as OSD, is micromanaging the program and creating unnecessary delays.
- Funds management function often becomes involved in prescribing contract methods and even deciding what to buy.

Question 6: Modification Funding Process

A. Lack of flexibility

- A system manager should be permitted to spend limited funds on his own authority; i.e., a small, inexpensive part may cause major operational problems, but it cannot be fixed without AFLC approval and consequent time delay.
- There are too many funding channels, e.g., engineering/modification funds, spares (O&M), software, and depot installation funds (DPIN).
- Time restraints placed on type of funds used create planning and budgeting problems.
- For advanced systems there should be a contingency fund for unexpected modification requirements.
- A capability is needed to fund software with hardware funds.
- The system is overburdened with an excess of unfunded requirements competing for the same funds regardless of the magnitude of the modification.
- Funding process is OK when cost estimates are accurate; however, the process is not responsive to cost fluctuations.
- More funding flexibility is needed. AFLC has requirements for 3600 funds, such as funding changes in software after PMRT.
- The requirement to provide hardware with first-year money in a multiple-year program is wasteful and provides little benefit.

- Class V modifications suffer from the funding constraints imposed by BP1100 account boundaries. Class V funding should be the same as for new-weapon system procurement.

B. Funding process too slow, causes delays

- Delays in moving money frequently result in cost increases.
- Funding is the biggest roadblock to getting anything done.
- Funding procedures are too complex to get timely implementation, frequently causing loss of currency of contractor quotation.
- Too many organizations are required in the process to release and allocate funds. Each organization adds its constraints. Timing is delayed because of contract requirements, resulting in program delays and cost increases.

C. Inappropriate division of modification funds

- Class IV and V modification funds should be grouped together. Funds should be allocated or priority-ranked by weapon system.
- Class IV and V modification funds should be grouped together for PRG and funded as one.

D. Inadequate long-range budget planning

- There is a failure to recognize modification procurement and installation funding constraints during determination of programs authorized to enter FSED.
- The biggest problem with funding is the supposition that most modifications can be identified, by modification number, for funding 16 months before the funds are first needed. This cannot be done very well.
- OSD-provided inflation factors are too low, resulting in overruns that are really well accounted for.
- Travel funds should be approved when Form 48 is approved.
- Basic problems with funds are that planning up front is incomplete, baseline design does not solidify, and requirement is not baselined -- all of which generate delays and thus increase funding.
- Funding and budget process bogs down in the item management/procurement area, resulting in nonavailability of items needed to support systems coming into inventory as part of a modification program.

Question 7: Cost Estimating for Planned Modifications

A. Lack of tools or data

- Escalation factors are not geared to current inflation rates.
- There is no thorough cost-benefit analysis versus capability, e.g., life cycle on aging weapon systems and long-term program modification installations.
- There is a lack of data and disciplined process.
- There is too much reliance on contractor ECPs -- no adequate tools for in-house estimates.
- There is no real basis to validate costs. There is a need to develop tools and rationale in this area.
- The tools are probably OK for the purpose intended, but input data are weak.
- Software nearly always costs more than the estimate, because it takes longer to develop than was planned -- similar problems with integration estimates.
- Modification managers must often rely on contractors' estimates. Initial estimates are generally optimistic for lead time and basic costs. Inflation and additional engineering efforts will usually increase total costs significantly.
- There is no standard agreement (AF, MAJCOMS) concerning what a cost analysis should include as a minimum baseline.

B. Lack of understanding of or improper use of tools available

- Most cost estimators have inadequate knowledge of engineering design aspects and vice versa.
- Managers are forced to budget low to obtain program approval.
- There is a lack of trained personnel.
- Appropriate tools exist, but they are neither well understood nor applied consistently.
- The MPA process is very difficult to prepare the first time.

C. Lack of system definition and costs hurriedly prepared

- The cost-estimation process is often performed hurriedly, thereby resulting in inaccurate costs.
- Many times the direction does not allow sufficient time to perform proper planning and, budgeting, because of the pressure to provide data to support budget process without adequate research.

- Accurate cost estimates cannot be made because it is not known what the configuration of the aircraft will be when the modification is installed.
- Not enough homework is accomplished on what the modification entails. Often the contractor is overselling the modification from the outset.
- Modification cost estimates have low credibility because of the lack of definition of the modification at the time the estimates are made.

D. Obsolete cost estimates because of lengthy modification process

- We underprice most of the time because of the time it takes between estimate and contractor implementation.
- We must know how and why weapon-system program parameters change, and we must keep life-cycle-cost analysis up to date for credibility.

Question 8: Weapon System Integration Architectures

A. Interface standards needed

- Interface standards are needed to permit adequately justified deviations.
- Standards are needed because of interdependence of subsystems. Deviation from standard should be by exception only. We cannot afford to reintegrate with each new addition.
- Development of more standards is needed. The Air Force should start with small areas that can be handled and demonstrated within a reasonable time.
- Top-level standardization is needed for interface concepts and family of weapons approaches; however, this standardization must not work against introducing new technology over the life of the weapon systems.
- Standards should be developed with using command participation.

B. Insufficient advanced planning for future architecture

- A P^3I approach to weapon system development is needed.
- We need to design weapon systems to be modified -- it is inevitable.
- There is not enough advanced planning. More standardization programs (e.g., PME, 1553) are needed and those that are continuing must be implemented.
- Long-range planning in architectural concepts design is essential.

- Advanced planning for integration is needed. Standards are needed and should be implemented. Current efforts such as family of weapons concept and NATO compatibility policies should also be supported at all levels.

Question 9: Impact of Modification on Weapon System

A. Lack of past planning and need for planning for future standards

- There is a lack of long-range planning.
- The piecemeal approach to systems modification is caused by lack of master planning.
- We must build on lessons learned and plan ahead for future standards.
- Advanced master modification planning is needed, with visibility above the SM and SPO level.
- Better planning is needed on new-start programs. Initial concepts versus final capability are often different.
- There is a need to build in future provisioning capability (P^3I approach).

B. Inadequate early engineering and lack of technical management

- There are poor configuration management controls throughout the total weapon system program.
- There is poor technical management.
- Modifications are inadequately evaluated before production go-ahead.
- There is poor requirement definition and a lack of baseline engineering design. Programs are swayed by technical advances during development.
- Inadequate early engineering results most probably because of improvements in the state of the art or a change in requirements during some part of the acquisition process.
- There is a lack of active system manager involvement throughout the development cycle. Two-way communication is needed.

C. Insufficient growth capability built into original aircraft

- There is insufficient growth capability in basic aircraft.
- There is an attempt to incorporate mission capabilities for which the weapon system was not designed.
- During aircraft development we do not design in all the growth we should have.
- There is a need to commit, up front, for growth capability.

D. Inadequate time allowed for technology to mature

- Incorporation of state-of-the-art products progresses too rapidly in existing weapon systems.

E. Failure to freeze modification design

- Changing requirements and additions to "make it do more" are permitted.
- We keep adding to modifications as they progress.
- Design cuts are required to meet cost growth.

Question 10: Most Critical Issues

A. Modification process too slow, cumbersome, and complex

- There are multiple, overlapping, and poorly defined layers of responsibility. There is no clear and simple description of process and various responsibilities.
- Procurement process is slow.
- There are delays between submission and implementation.
- There are too many funding delays and approval levels.
- There is too much paperwork.
- Budget approval time is too long.
- There are too many organizations/people imposing their project controls.
- Complex funding is controlled by different agencies, requiring different inputs for approval -- some one-year money, some three-year money.
- The length of time is too great to get contract awarded and produced.
- The approval and funding process is complex.
- Material lead times are too long.
- Too many players are involved in modification approval process.
- Complex modifications become obsolete by the time they are fielded.
- The time required to start a modification is too long, i.e., requirement validation, MPA preparation, and approval cycle.
- The process is too complex.
- Too much time is spent reviewing modification proposals.
- Too many people and offices are involved in the process.
- There is too much red-tape inefficiency.

- The numerous coordinations that are required cause undue delays.
- There is too much red tape in obtaining modification approval, i.e., Class IV -- more than $5 million requires preparation of Form 48 and advanced acquisition plan. Then AFLC is briefed on acquisition approach clearly outlined in the acquisition plan. This briefing is redundant and unnecessary.
- Funding delays cause an increase in negotiated prices.
- There is a lack of decision-making capability by the system managers.
- The budget process is overcomplicated.
- The SON process is too slow and after the fact.
- There is a rapid cost escalation by contractors but slow procedural reaction by USAF.
- Milestones and cost estimates are required to be too precise. If even a slight error or change occurs on CCB forms, coordination must be accomplished again, when, in fact, the figures and dates may be only rough estimates.
- There are delays in engineering evaluations and CCB approvals.
- There are overcautious decision-makers who check and recheck.
- The procurement process should begin early (do those things which can be done before funding authority approval).

B. AFLC/AFSC split management

- There is a need for a modification "czar" backed by AF/CC.
- AFSC is too much involved in managing modifications instead of functioning primarily as developers.
- There is a continuing pwer struggle for management of early production between AFSC and AFLC.
- Modifications are split midstream between AFLC and AFSC.
- Everyone wants control of funds and decisions, which results in command bickering.
- There is a lack of PMD direction for single modification manager.
- There is a lack of effective single manager from "cradle to grave."
- There is no single responsible agent for each weapon system.
- Strong centralized management control is needed to assure proper AFSC-AFLC interface.
- The developer is driven to cost and schedule, and implementor must live with results.
- There is a loss of expertise with PMRT.
- AFSC wants to "sell off" a product that AFLC then has to support.

- System manager lacks control over his weapon system.
- One focal point is needed for entire modification effort. Currently each side (development, implementation) is concerned with different aspects. This is particularly true for smaller programs.
- A single command or program office is needed during development, acquisition, and support phases of a program to integrate total effort and act as an overall focal point with full responsibility.
- There is a lack of effective communication and interplay between all parties, particularly between AFSC and AFLC early in the development process.
- Better communication is needed between user and implementors for Class IV modifications.
- SM and IM are not involved until after the production decision. The result is that total weapon system integration is not addressed.

C. Lack of master modification planning for weapon system

- An integrated modification plan is needed by weapon system.
- There is lack of an active consolidated management system.
- There is a lack of a clear plan to adhere to.
- A composite modification package is needed that accounts for the entire weapon system. The present method of individual modifications is not efficient.
- There is a lack of total weapon system planning.
- There is no consideration of other modifications, time phasing, and operational impact.
- Coordination is lacking between modification programs.
- There is an inability to reserve space on aircraft for modification.
- There is poor configuration control.
- There is a lack of a detailed understanding of the total requirement and its impact on out-year development.
- There is no way to group modifications into logical package.

D. Lack of R&M aspects -- no accountability by developers

- AFSC downplays logistics aspects at laboratories, test groups, and R&D field units.
- High-level support is inadequate for modifications to improve reliability and reduce LCC.

- There is a lack of accountability by developer for support aspects.
- AFSC is schedule-driven, not requirements-driven.
- SPOs often develop systems that lack adequate supportability.
- There is an inability of requirements to adequately consider logistics supportability.
- There is a failure to adequately consider logistics support aspects.
- AFLC participation is needed prior to PMRT to ensure adequate consideration of logistics support aspects (need AFLC acceptance criteria before production decision).
- There is inadequate R&M funding for new development.

E. Lack of understanding of modification process

- There is a serious lack of understanding of formal guidance and the modification process -- need modification training program.
- Supervisors lack logistics training.
- The task of learning how modification process works in time to follow it correctly is nearly impossible.
- There is a lack of experienced personnel. No formal modification management courses are available.
- There is a lack of proper training (in modification procedures).
- Very little training is available on modification processing procedures.
- People involved in the system do not understand the modification process. There is a need for a training program across all organizations involved in the modification process.
- Contractors and AFPRO personnel do not understand the modification process -- need instruction.

F. Inadequate requirements definition process

- The Air Staff process rarely ever results in the rejection of any MAJCOM requirement.
- There are poorly defined requirements and a lack of baseline planning.
- Operational concept is continually changing.
- Requirements and analysis in early program stages are inadequate.
- Requirements are inadequately defined and unrealistic.
- There is an inability to predict requirements.

G. Other comments

- Operating commands should control modification funds.
- There is little discipline in the system as far as setting and adhering to priorities.
- Regulations tie hands of system managers.
- There is no operator accountability for modifications versus available funds.
- Class IV modifications are tied to a fixed amount of money. SMs should have a 15 to 20 percent buffer for inflation and interface problems.
- Flexibility in realigning funds is inadequate at the working level.
- Cost estimates are inadequate or inaccurate.
- Three-year versus one-year funding makes budget planning difficult.
- There is poor priority ranking of large modifications.
- Modification programs must be realistically forecast by the time the hardware program is in FSED to allow development of engineering and configuration management interfaces.
- Integration and software cost estimates are inadequate or inaccurate.

APPENDIX C

SUMMARY BRIEFING OF THE AIRCRAFT MODIFICATION MANAGEMENT EVALUATION

The following pages of this appendix present the summary briefing of the overall study effort.

ARINC

AIRCRAFT MODIFICATION MANAGEMENT EVALUATION

ARINC Research Corporation
a Subsidiary of Aeronautical Radio, Inc.
2551 Riva Road
Annapolis, Maryland 21401

BACKGROUND

- Use of existing aircraft requires an aggressive modernization program to maintain operational preparedness.
- Rapidly expanding technologies provide a high degree of capability to an aging force.
- An intensive aircraft modification program is expected during the next two decades because of these factors.

OBJECTIVES

- Identify major technical and managerial issues
- Develop structured approach to resolve issues

TASKS

- Survey modification problem areas
- Analyze modification management problems

APPROACH

Task 1: Conduct preliminary survey of aircraft modification problems

- **Literature Search**
- **Questionnaire**
- **Interviews**

LITERATURE SEARCH

- DLSIE
- AFIT School of Logistics
- Lockheed DIALOG

QUESTIONNAIRE

- Based on literature search and company "brainstorming"
- Mailing list based primarily on current modification review by AFSC

INTERVIEWS WITH KEY USAF PARTICIPANTS

- Views of military modification managers (04 through 07) and senior Air Force civilians (GS-14 and -15) were solicited at HQ USAF, AFSC, ALD, AFLC, and ALCs.
- Interviews employed same questions as the mailed questionnaire, but in an "open ended" form.

APPROACH

Task 2: Perform Analysis of Modification Issues

- Examine and classify survey results
- Identify cause-effect relationships
- Develop hierarchy of key problems
- Develop structured approach to resolve issues

SURVEY RESULTS

Question 1: Modification Requirements Definition

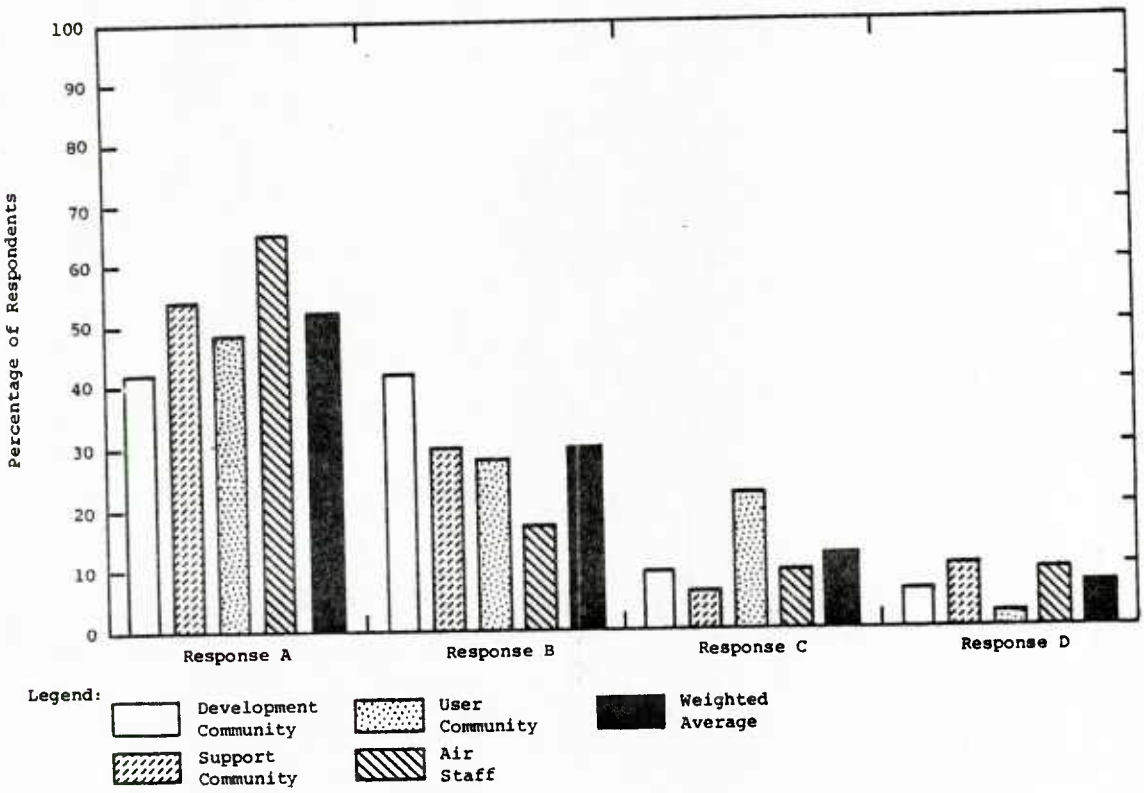
Respondents were requested to rate modification requirements as follows with respect to definition:

A. Are as specific as could be reasonably expected

B. Are poorly defined

C. Are too specific, i.e., tend to exclude reasonable alternatives

D. Other



(continued)

SURVEY RESULTS (continued)

Question 2: Timeliness of the Modification Requirements Process

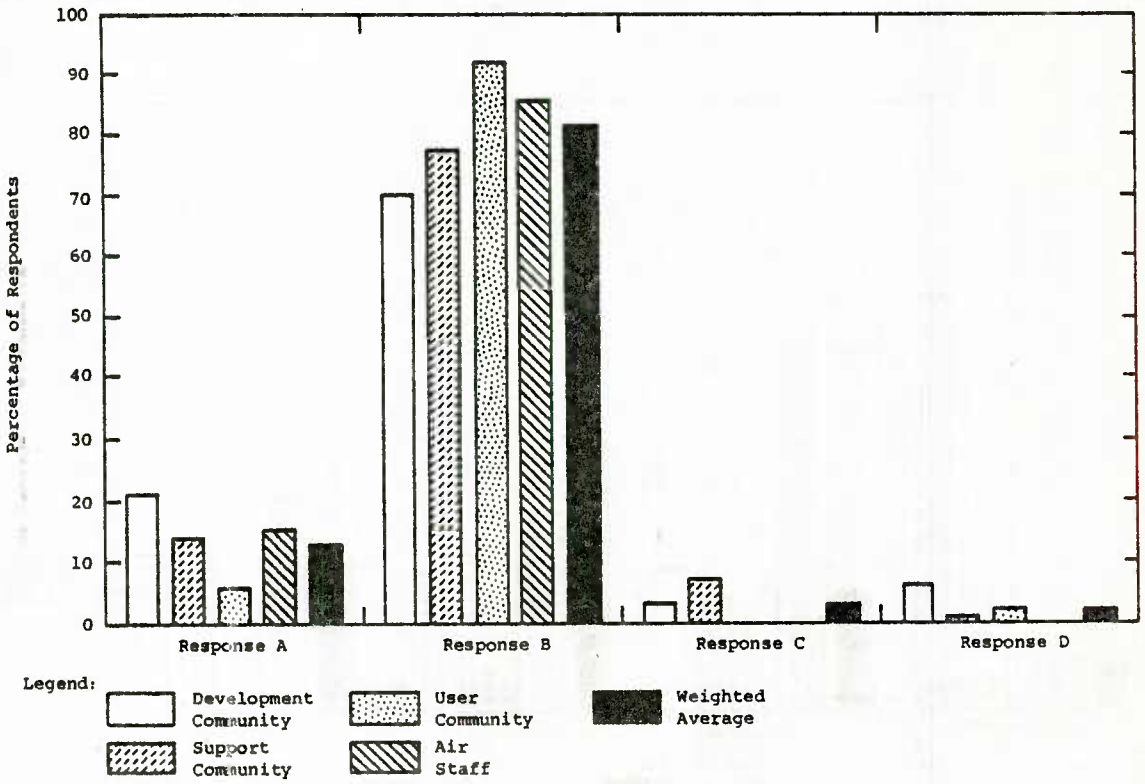
Respondents were requested to rate the modification requirements process as follows with respect to timeliness:

A. Is an appropriately considered process

B. Takes too long to provide timely solutions

C. Is too short to adequately consider all decision aspects

D. Other



(continued)

SURVEY RESULTS (continued)

Question 3: Criteria for Modification Priorities

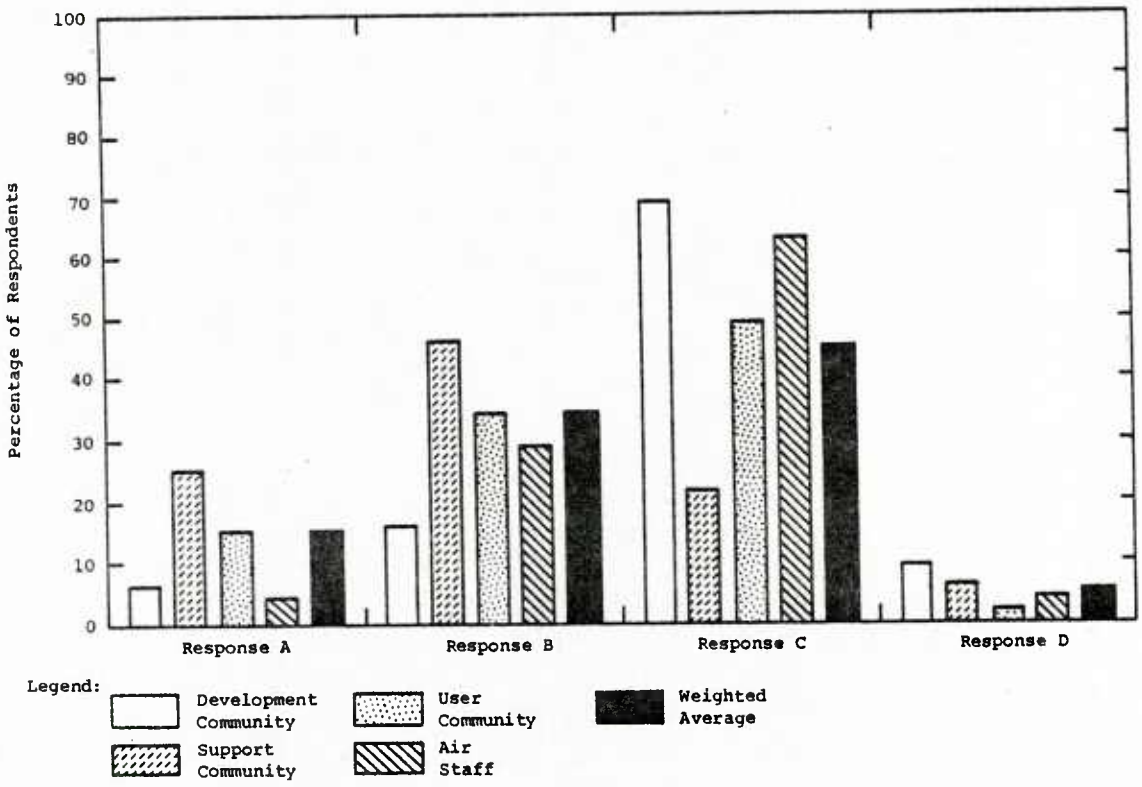
Respondents were requested to rate criteria for modification priorities as follows:

A. Should be clearly defined in quantitative figures of merit

B. Should be subjectively determined on the basis of operational and cost factors

C. Should be expressed as a balance of qualitative and quantitative factors

D. Other



(continued)

SURVEY RESULTS (continued)

Question 4: Hardware Development and Hardware Implementation as Separate and Distinct Activities

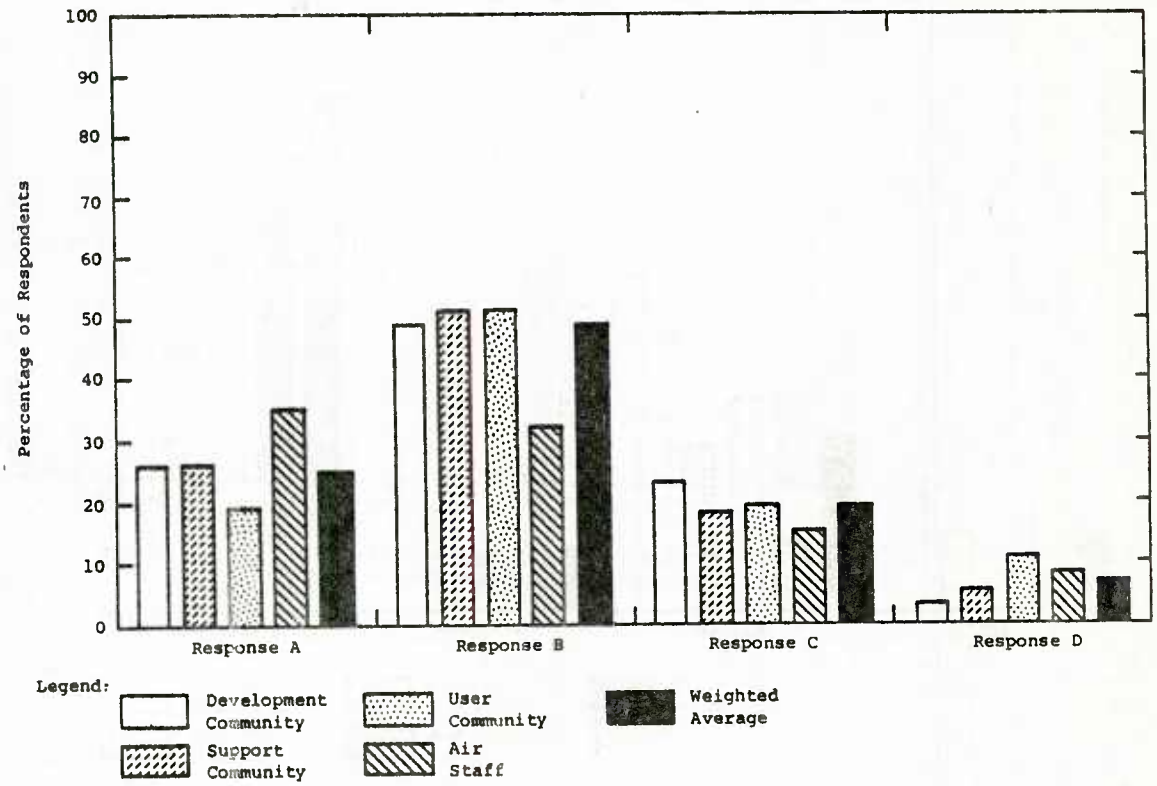
Respondents were requested to rate hardware development and implementation for modification programs as follows:

A. Are separate and distinct activities that can be managed independently by AFSC and AFLC

B. Should be assigned to either AFSC or AFLC from "cradle to grave"

C. Should fall under one line of authority and responsibility across command lines at the Air Staff level

D. Other



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SURVEY RESULTS (continued)

Question 5: Modification Management Function at the Air Staff Level

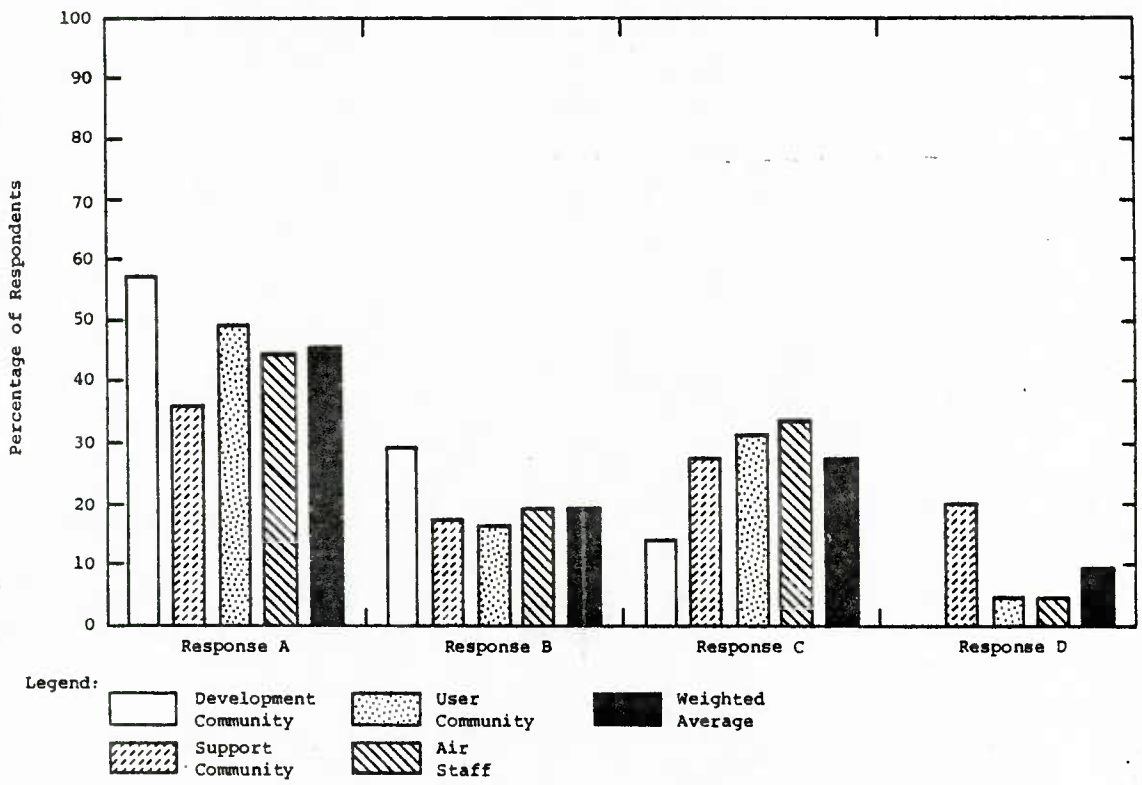
Respondents were requested to rate the modification management function at the Air Staff level as follows:

A. Is an arbitrary process, of which the outcome is largely dependent on the persuasiveness of the PEM

B. Results in too much involvement in the "working level" management of modification programs (micro-management)

C. Provides the needed Air Staff support and involvement regarding the modification process at the field level

D. Other



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SURVEY RESULTS (continued)

Question 6: Modification Funding Process

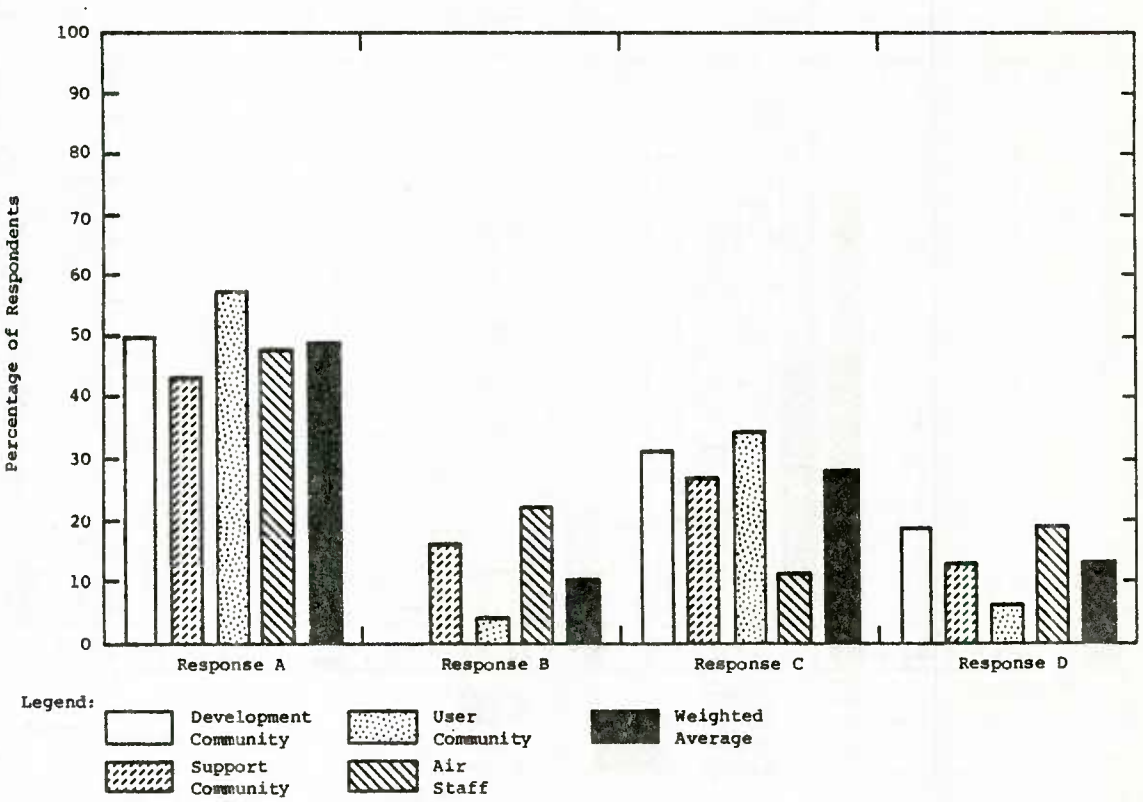
Respondents were requested to best characterize the modification funding process as follows:

A. An artificially difficult coordination environment imposed by the requirement to use three-year procurement funds for hardware and one-year O&M funds for installation

B. A consistent, methodical process that determines the equitable distribution of modification funds

C. A source of program delays because of the SM's and SPO's inability to move funds quickly from one line item to another

D. Other



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SURVEY RESULTS (continued)

Question 7: Cost Estimating for Planned Modifications

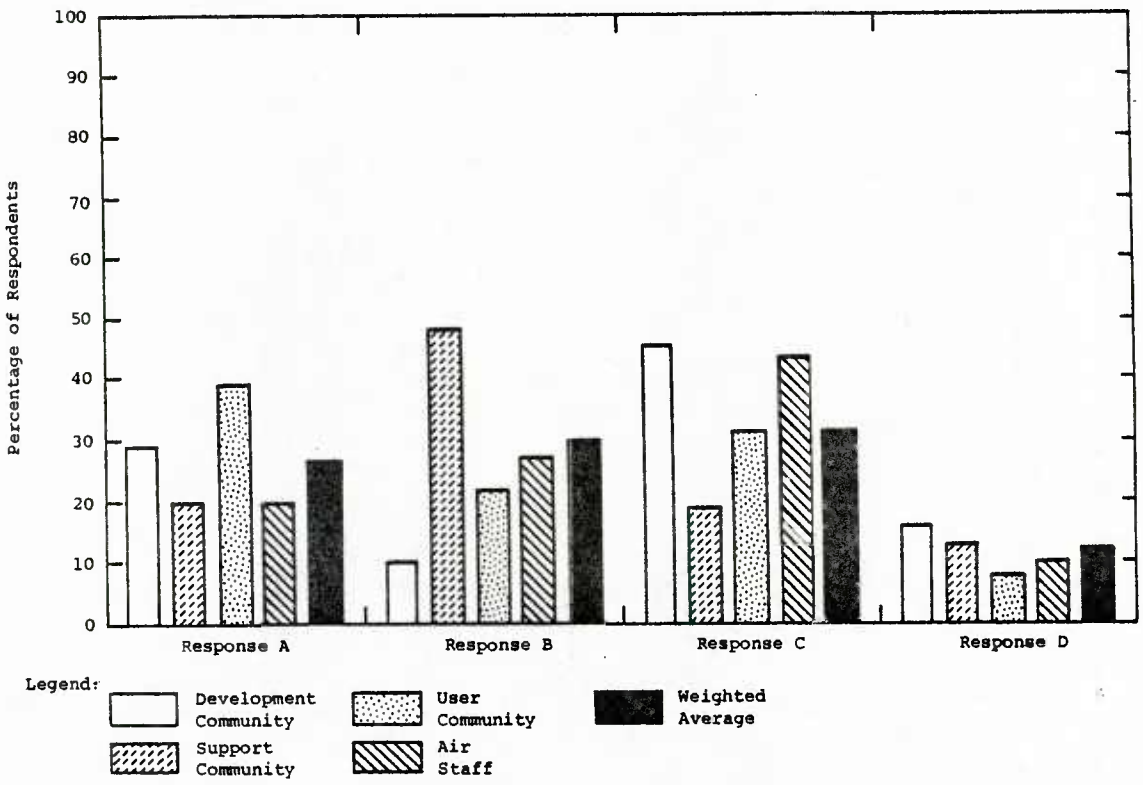
Respondents were requested to rate cost-estimating for planned modifications as follows:

A. Is not a serious deficiency in the modification process

B. Is inadequate because of a lack of cost-estimating tools or data

C. Is inadequate because of a lack of understanding of or improper use of tools already available

D. Other



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SURVEY RESULTS (continued)

Question 8: Weapon System Integration Architectures

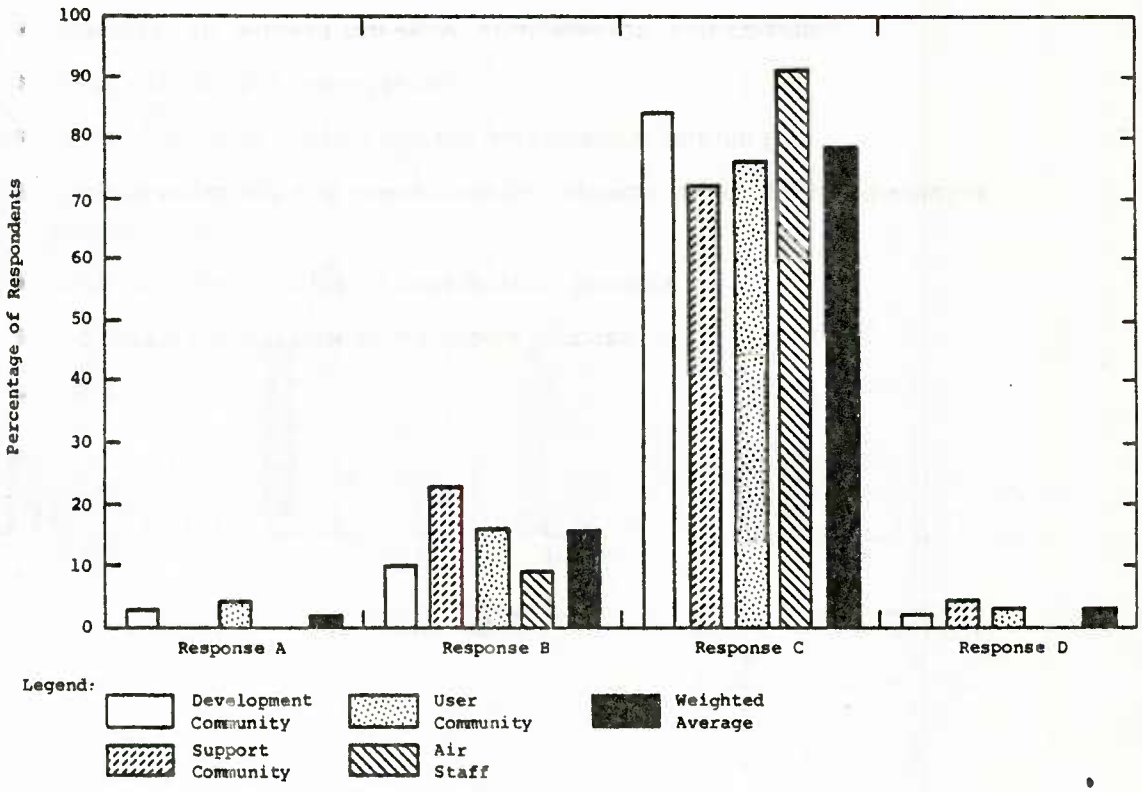
Weapon system integration architectures do not always lend themselves to the incorporation of new subsystems introduced as a part of a modification program. Respondents were requested to rate the integration architecture as follows:

A. Should be left to the discretion of the aircraft developer

B. Should be established within strict standards established at the AFLC or AFSC level

C. Should have "envelopes" of interface requirements that leave some degree of flexibility

D. Other



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SURVEY RESULTS (continued)

Question 9: Impact of Modifications on Weapon System

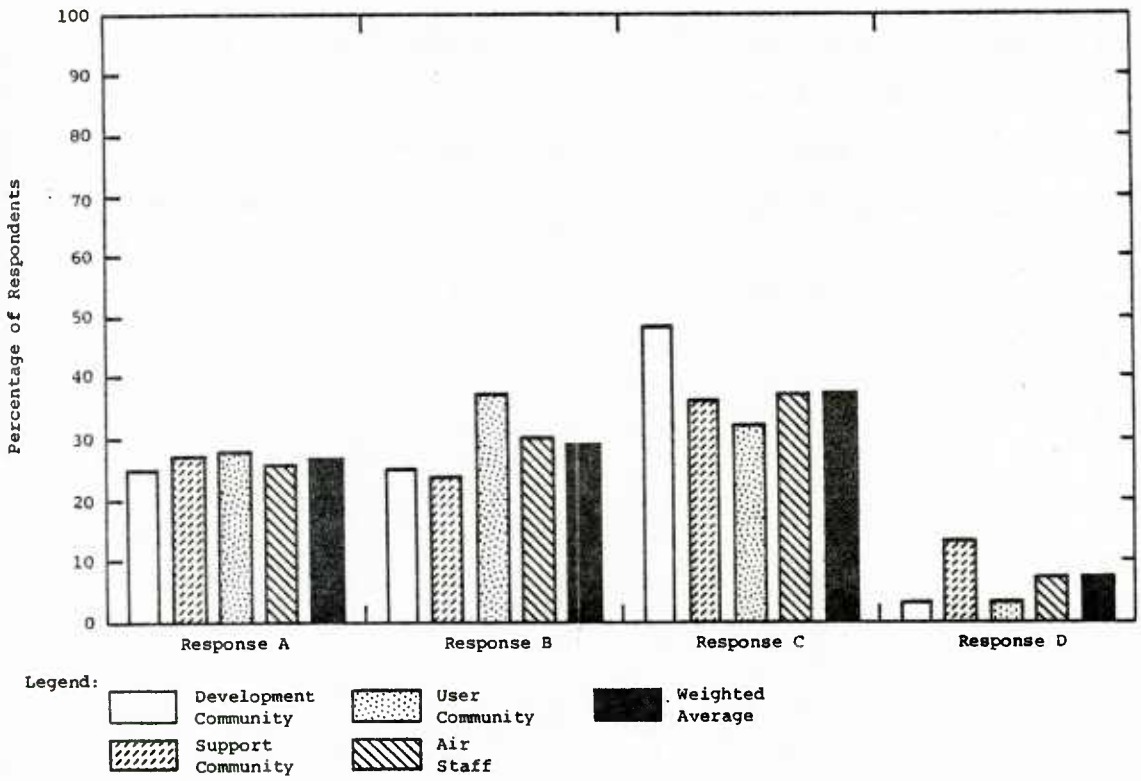
Respondents were requested to identify from among the following the reasons for the adverse effects of weapon system modifications made to support the installation of new equipment in older aircraft:

A. Inadequate engineering in the early stages of a modification program

B. Numerous changes in the new hardware design by the time it is integrated into the weapon system

C. Lack of communication between the subsystem developer and the weapon system manager

D. Other



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SURVEY RESULTS (continued)

Question 10: Most Critical Modification Management Issues (by Percentage of Responses)

• Modification process too slow, cumbersome, and complex	42
• AFSC/AFLC split management	19
• Lack of weapon system master modification planning	12
• Lack of reliability and maintainability aspects or no lifetime developer accountability	8
• Lack of understanding of modification process	6
• Inadequate requirements definition process	5
• Other	8

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ANALYSIS OF ISSUES

- Examine and classify survey results
  - Policy
  - Technical
  - Planning
  - Business
  - Requirements
  - Funding and Budgeting
- Identify cause-and-effect relationships, e.g.; business

Cause	Effect
• Inability to negotiate multiyear procurement options	• Contractor increases his costs yearly; contractor production cycle is lengthened.
• No procurement negotiation work until funding authority paperwork complete	• Procurement cycle is lengthened.
• Inadequate software acquisition policies	• Air Force lacks software data documentation and is tied to contractor for lifetime support.
• Complex procurement procedures legal process	• Delays, schedule slips, and cost increases are incurred.

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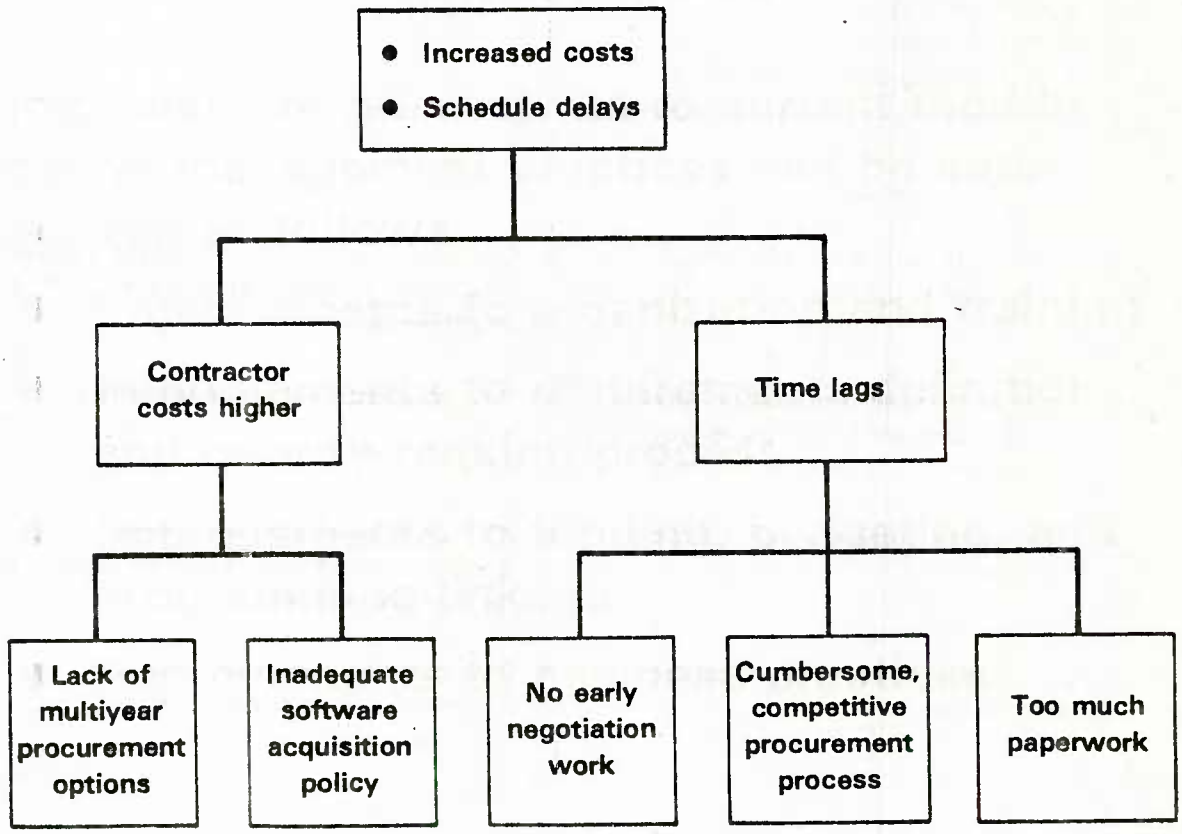
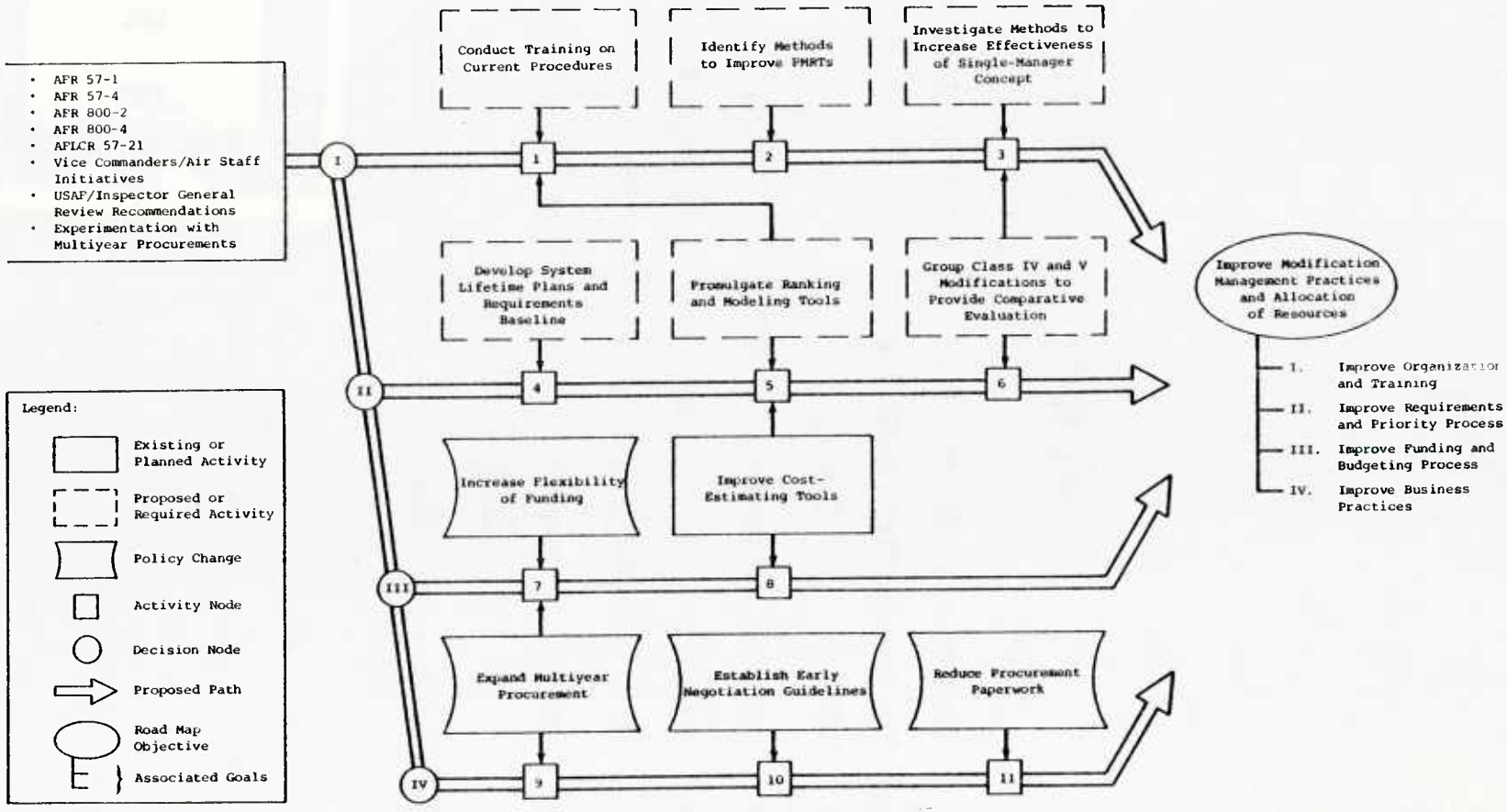
ANALYSIS OF ISSUES (continued)

- Develop hierarchy of key problems; e.g., business



"ROAD MAP" OF MODIFICATION MANAGEMENT INITIATIVES



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CONCLUSIONS

Improvement alternatives to current modification management practices can be categorized as follows:

- Improvements to organization and training
- Improvements to requirements definition and priority-ranking process
- Improvements to funding, budgeting, and programming linkage
- Improvements to business practices

RECOMMENDATIONS

- Coordinate study results with current Air Force efforts.
- Discuss initiatives with cognizant Air Force organizations.
- Sponsor activities with current available resources.
- Plan for implementation of subsequent activities.

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