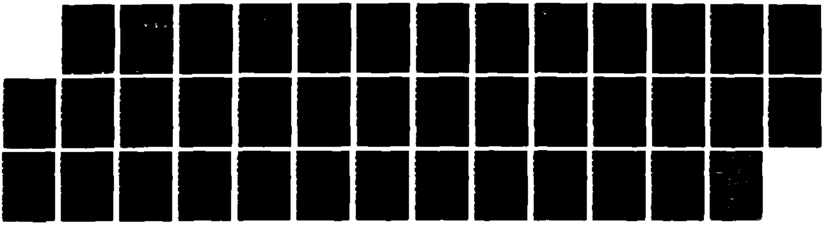
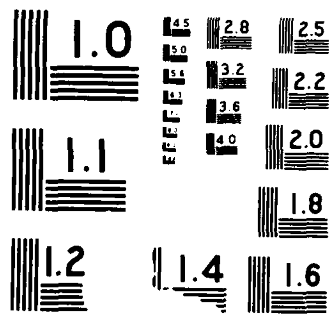
AD-A192 535 AC-130U GUNSHIP WARRANTY ANALYSIS: LESSONS LEARNED(U) 1/1
AIR COMMAND AND STAFF COLL MAXWELL AFB AL
P A BLATCHLEY APR 88 ACSC-88-0310

UNCLASSIFIED F/G 1/3.5 NL




1.0
1.1
1.2
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0

AIR COMMAND AND STAFF COLLEGE

STUDENT REPORT

AC-130U GUNSHIP WARRANTY ANALYSIS: LESSONS LEARNED

MAJOR PETER A. BLATCHLEY 88-0310

"insights into tomorrow"

DISCLAIMER

The views and conclusions expressed in this document are those of the author. They are not intended and should not be thought to represent official ideas, attitudes, or policies of any agency of the United States Government. The author has not had special access to official information or ideas and has employed only open-source material available to any writer on this subject.

This document is the property of the United States Government. It is available for distribution to the general public. A loan copy of the document may be obtained from the Air University Interlibrary Loan Service (AUL/LDEX, Maxwell AFB, Alabama, 36112-5564) or the Defense Technical Information Center. Request must include the author's name and complete title of the study.

This document may be reproduced for use in other research reports or educational pursuits contingent upon the following stipulations:

- Reproduction rights do not extend to any copyrighted material that may be contained in the research report.

- All reproduced copies must contain the following credit line: "Reprinted by permission of the Air Command and Staff College."

- All reproduced copies must contain the name(s) of the report's author(s).

- If format modification is necessary to better serve the user's needs, adjustments may be made to this report--this authorization does not extend to copyrighted information or material. The following statement must accompany the modified document: "Adapted from Air Command and Staff College Research Report ___(number)___ entitled ___(title)___ ________ by ___(author)."

- This notice must be included with any reproduced or adapted portions of this document.

REPORT NUMBER 88-0310

TITLE AC-130U GUNSHIP WARRANTY ANALYSIS: LESSONS LEARNED

AUTHOR(S) MAJOR PETER A. BLATCHLEY, USAF

FACULTY ADVISOR MAJOR ALAN W. SCHOOLCRAFT, ACSC/3821 STUS

SPONSOR LIEUTENANT COLONEL WILLIAM CUNNINGHAM, AFALC/PP

Submitted to the faculty in partial fulfillment of requirements for graduation.

AIR COMMAND AND STAFF COLLEGE
AIR UNIVERSITY
MAXWELL AFB, AL 36112-5542

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

A 1 9 9 . 5 3 5

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT STATEMENT "A" Approved for public release; Distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) 88-0310	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION ACSC/EDC 6b. OFFICE SYMBOL *(If applicable)*	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS *(City, State, and ZIP Code)* Maxwell AFB AL 36112-5542	7b. ADDRESS *(City, State, and ZIP Code)*
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS *(City, State, and ZIP Code)*	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO / WORK UNIT ACCESSION NO.

11. TITLE *(Include Security Classification)*
AC-130U Gunship Warranty Analysis: Lessons Learned

12. PERSONAL AUTHOR(S)
Blatchley, Peter A., MAJOR, USAF

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(Year, Month, Day)*	15. PAGE COUNT
	FROM ______ TO ______	1988 April	36

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
FIELD	GROUP	SUB-GROUP	

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

The AC-130U Gunship Program Office conducted a warranty cost-benefit analysis during its source selection process. The analysis of that effort provides lessons learned for future warranty evlauations.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL ACSC/EDC Maxwell AFB AL 36112-5542	22b. TELEPHONE *(Include Area Code)* (205) 293-2867 22c. OFFICE SYMBOL

DD Form 1473, JUN 86 *Previous editions are obsolete.*

SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

PREFACE

My sincere thanks to Captain Kermit Stearns, who, as the prime mover behind the Gunship warranty evaluation effort, taught me more than I ever expected to know about cost-benefit analysis. Also, to Major Alan Schoolcraft, who as advisor to this project, offered such sound technical advice. Finally, a word of appreciation to my family, Eve, Christopher and Jonathan, who provided invaluable moral support throughout this project. Thank you, all!

TABLE OF CONTENTS

Preface..iii
About the Author..v
Executive Summary..vi

CHAPTER ONE--INTRODUCTION.................................1

CHAPTER TWO--HISTORY OF WARRANTIES AND WARRANTY COST-BENEFIT ANALYSIS IN DOD
DoD Warranty History......................................3
DoD Warranty Cost-Benefit Analysis History................5

CHAPTER THREE--EXISTING WARRANTY EVALUATION TOOLS
Underlying Theory...7
Warranty Evaluation Tools.................................9

CHAPTER FOUR--AC-130U WARRANTY PROVISIONS AND COST-BENEFIT ANALYSIS METHODOLOGY
AC-130U Warranty Provisions..............................13
AC-130U Cost-Benefit Analysis Methodology................16

CHAPTER FIVE--ANALYSIS OF AC-130U WARRANTY COST-BENEFIT ANALYSIS
Strengths..21
Weaknesses...22

CHAPTER SIX--CONCLUSIONS AND RECOMMENDATION
Conclusions..25
Recommendation...26

BIBLIOGRAPHY...27

ABOUT THE AUTHOR

Major Pete Blatchley is a 1975 graduate of the United States Air Force Academy. A senior pilot with over 2500 flying hours in C-141 and CT-39 aircraft, Major Blatchley holds a masters degree in logistics management from the School of Systems and Logistics, Air Force Institute of Technology. He has logged three years of applied acquisition logistics management in the joint CV-22 Osprey and AC-130U Gunship Program Offices, Air Force Systems Command, Aeronautical Systems Division.

EXECUTIVE SUMMARY

REPORT NUMBER 88-0310

AUTHOR(S) MAJOR PETER A. BLATCHLEY, USAF

TITLE AC-130U GUNSHIP WARRANTY ANALYSIS: LESSONS LEARNED

I. Purpose: To analyze the methodology used by the AC-130U Gunship Program Office to evaluate its weapon system warranty during source selection, and to draw pertinent lessons learned from that experience.

II. Background: DoD is now required by law to procure cost-effective weapon system warranties in conjunction with most major weapon system acquisitions. But few useful tools are available to aid in the analysis of these warranties. Lacking a useful "off-the-shelf" warranty analysis tool, the AC-130U Gunship Program Office crafted a warranty cost-benefit analysis methodology and used it during the source selection of the Gunship. The challenges faced in the development and implementation of the AC-130U warranty analysis methodology suggest important "lessons learned" for future source selections.

III. Discussion: Recent legislation requiring the procurement of cost-effective warranties on most major weapon systems established the requirement for warranty cost-benefit analysis during source selection for that weapon. Following a futile search for a useful, "off-the-shelf" warranty evaluation tool, the AC-130U Gunship Program Office, in what turned out to be a pioneering effort,

developed its own warranty cost-benefit analysis methodology. The strengths of this in-house effort include the analysis' grounding in life cycle cost theory, involvement of functional area experts in its development and validation, and the foresight with which it was crafted. Its shortcomings include its failure to capture many of the relevant costs associated with the weapon system warranty, artificially-constraining assumptions, and a reliance on ultimately unobtainable data.

IV. Conclusions: DoD is required by law to procure cost-effective warranties on its major weapon systems. Consequently acquisition agencies must conduct some form of cost-benefit analysis to ensure the procurement of cost-beneficial warranties. Unfortunately few useful warranty evaluation tools exist today. The AC-130U Gunship warranty analysis effort highlights many of the shortcomings that characterize the few existing tools: a requirement for non-existent data, the inherent difficulty in forecasting future costs, the difficulty of translating physical performance measures into terms of dollars and cents, and the specialized nature of available tools.

V. Recommendation: DoD must develop easy to use, off-the-shelf warranty analysis tools for program office use during the critical source selection process. The tools must overcome the shortcomings of the few existing tools as cited above.

Chapter One

INTRODUCTION

DoD weapon system acquisition is one of the elemental processes that underlie the nation's ability to effectively apply military power in the pursuit of national interests worldwide. How well we acquire effective and efficient weapons --from rifles to main battle tanks, life rafts to nuclear submarines, radios to strategic bombers--in large part will determine the effectiveness of US armed forces in the future.

DoD acquisition agencies have been the target of considerable criticism in recent years as a result of a perception that these organizations have not been providing the services weapons of the right kind, quantity or quality. Congress has enacted legislation intended to improve the acquisition process. Two enactments in particular have had a significant impact on the weapon system acquisition process. In the Weapon System Warranty Act and the Defense Procurement Reform Act, Congress has required the DoD to obtain cost-effective manufacturer warranties on all new major weapon systems (13:5-9). The impact of this legislation has been a significant change in how the services acquire weapons.

While the services had procured some warranted systems prior to these two enactments, the use of warranties had not been widespread. But now that the Weapon System Warranty and Defense Procurement Reform Acts mandated the procurement of cost-effective warranties on all major weapon systems, major new decisions were required of acquisition agencies. The determination of whether or not a contractor's proposed weapon system warranty was cost-effective became a crucial judgement. Besides the obvious legal requirement, obtaining a cost effective warranty can reduce the life cycle cost of owning, supporting, and using a new weapon system, and improve its effectiveness.

This study examines the process employed by the AC-130U Gunship Program Office and Source Selection Team in evaluating the cost-effectiveness of the warranties proposed in three competitive bids. After a brief examination of the history of weapon system warranties within DoD (Chapter 2), this study presents a discussion of the basic theory that underlies warranty evaluation and samples some typical warranty cost-benefit analysis methodologies (Chapter 3). Chapter 4 describes the Gunship warranty provisions and the methodology used to evaluate the warranties proposed by the three defense contractors who competed for the nearly $1 billion contract. Chapter 5 offers an analysis of the strengths and weaknesses of the Gunship warranty cost-benefit analysis effort. Finally, Chapter 6 presents conclusions and a recommendation for the future application of warranty analysis tools.

The goal of this research project was to answer the question, "Are there lessons to be learned from the AC-130U Gunship warranty evaluation effort that may serve to improve future warranty cost-benefit analyses?" Such a question would suggest the author enters the research with knowledge of certain imperfections within the Gunship cost-benefit analysis. That is indeed the case. But any criticism of the methodology is, in part, self-criticism as the author was one of the prime architects and users of the Gunship warranty evaluation methodology.

Chapter Two

HISTORY OF WARRANTIES AND WARRANTY COST BENEFIT ANALYSIS IN DOD

DOD WARRANTY HISTORY

Warranties on DoD weapon systems are a relatively new phenomenon, although they were clearly in use prior to 1984 when Congress mandated their use. As early as 1965, the Armed Services Procurement Regulation (ASPR) called for the selective use of warranties (14:14). However, the ASPR guidance was widely " . . . interpreted to mean that use of an extensive, long-term warranty should be the exception rather than the rule" (3:2-2). In 1978 " . . .the Air Force Systems Command directed the expanded use of warranties in Air Force procurements" (14:16). That same year saw the birth of the Air Force Product Performance Agreement Center (PPAC) whose mission was " . . . to assist Air Force activities involved in the acquisition of defense systems . . . in selecting, structuring, pricing, negotiating, and implementing effective Product Performance Agreements," e.g., warranties (7:2-1). Beginning in 1981, the DoD Acquisition Improvement Program focussed attention on the use of warranties to improve the reliability and supportability of weapon systems (14:16). The Federal Acquisition Regulation (FAR), the successor to the ASPR and Defense Acquisition Regulation (DAR), addressed criteria and the government's rights in the structuring and use of warranties in 1984 (4:--). In the years just before the Weapon System Warranty Act and the Defense Procurement Reform Act, the acquisition community regarded warranties as a "standard option", though one only selectively applied (3:2-2). Clearly the history of warranties in the DoD predates the legislation that now requires their use.

In 1984, notwithstanding DoD's expanding application of weapon system warranties, and in response to perceived problems with the quality of certain newly-acquired weapons, Congress passed the Weapon Systems Warranty Act (WSWA) (Public Law 98-212). More popularly known as the Andrews Amendment, the Act was added to the DoD Appropriation Act of 1984 as Section 794 (13:5-6). The WSWA requires warranties on all new weapon system acquisitions in which the unit cost exceeds $100,000, or the total procurement cost exceeds $10 million (10:1). The enactment stipulates that:

> [N]o funds may be obligated or expended for the procurement of a weapon system unless the prime contractor guarantees that the system is designed and manufactured to meet the government's performance requirements and is free from all defects in material and workmanship that would cause it to fail to conform to performance reqirements (10:1).

The effect of this legislation was weapon system warranties were now required by law, and in only two circumstances could the Secretary of Defense waive that requirement: the warranty would not be in the interest of national defense, or it would not be cost effective (7:1-4).

The WSWA represented a significant departure from FAR procedures for government acquisition agencies and defense contractors alike. For DoD, warranties were no longer an option available to the Program Manager but a statutory requirement. Perhaps more significantly, the WSWA saddled the prime contractor with overall responsibility for warranting the quality of the materials, the workmanship, and essential performance of the weapon at the system level (13:7-8). Previously, the FAR focussed on the component level in its warranty treatment and had held the manufacturer of the specific component liable for defective material or workmanship (13:7-8). With WSWA, the prime contractor was now responsible for making all the parts and the system itself work right.

The immediate result of the WSWA was a storm of protest and criticism from the DoD and defense contractors alike. Strong lobbies were mobilized in Congress, attacking the Public Law on the basis of its certain unfavorable impact on the cost of new weapon systems and the loss of flexibility in government program management (13:8). The following year, 1985, largely in response to this lobbying, in particular the commercial lobby, Congress modified the original law by passing the Defense Procurement Reform Act (Public Law 98-525), as an amendment to the DoD Appropriations Act of 1985.

The Defense Procurement Reform Act sustained the basic requirements of its predecessor. Weapon system warranties were still required on materials, workmanship, and performance, and the prime contractor was still responsible and liable for system level performance. The significant change embodied in the latter Public Law reflected Congress' intent that the DoD procure only cost-beneficial warranties. Consequently, the Defense Procurement Reform Act required the DoD to conduct a cost-benefit analysis to ensure acquisition agencies procure only warranties economically favorable to the government. The

Act ensured Congressional oversight into the warranty procurement process as it required the notification of Congress in the event an acquisition agency proposed to procure a non-cost-beneficial warranty (16:3). The DoD has acknowledged the Defense Procurement Reform Act by modifying its Defense Federal Acquisition Regulation Supplement (DFARS). DFARS Subpart 46.770, "Use of Warranties in Weapons System Procurements," encompasses the tenets of the new legislation including the requirement for a cost-benefit analysis (4:46.7-3 to 7-8).

The use of warranties in DoD, then, has progressed from an allowance for the selective implementation of component level warranties by the ASPR, DAR, and FAR, to the statutory requirement for the procurement of cost-beneficial, system-level warranties on major weapon systems. But to what extent has the DoD performed the required cost-benefit analysis in the procurement of weapon system warranties?

DoD WARRANTY COST-BENEFIT ANALYSIS HISTORY

In February 1987, the Government Accounting Office (GAO) reported that in the 97 procurement contracts reviewed, in only nine had " . . .the procurement activities performed [warranty] analyses that addressed basic cost-effectiveness criteria" (10:3). The GAO determined the DoD had spent $180 million on warranties for which there had been " . . . no determination that the benefits to be derived under the warrant[ies] were worth the cost" (10:3). What are the reasons behind this apparent failure to comply with the intent of Congress as reflected in the Defense Procurement Reform Act?

Unfortunately the GAO report shed little light on any underlying causes of DoD's failure to perform the cost-benefit analyses required by the Defense Procurement Reform Act. But the reasons became apparent to the author during the planning and the conduct of the source selection for the AC-130U Gunship aircraft in the spring of 1987.

Primary among the reasons is the lack of guidance available within the DoD for conducting warranty cost-benefit analyses. Indeed, in the months leading up to the Gunship source selection, the Program Office was unable to obtain anything resembling a useful model or methodology for such an analysis. The ultimate futility of our search is echoed by the Defense Systems Management College which reported in its Warranty Handbook that " . . . [t]here is no DoD warranty cost-estimation model that addresses all the warranty requirements of . . ." the Defense Procurement Reform Act (3:7-13).

However, several DoD warranty cost models have evolved, some tailored for a specific type of warranty, others addressing only a subset of the total costs involved. A sampling of the existing warranty evaluation tools, preceeded by a discussion of their underlying cost estimation methodology is presented in Chapter 3.

Chapter Three

EXISTING WARRANTY EVALUATION TOOLS

UNDERLYING THEORY

There is nothing particularly exotic about the theory underlying warranty cost-benefit analysis. "In analyzing warranties, the primary concern of both buyer and seller is cost. Accordingly, most of the models of warranty process that have been developed are, in essence, economic in nature" (1:6-23). In other words, warranty analysis, from either the buyer or seller's perspective, involves capturing or estimating the costs and benefits associated with the execution of the warranty. From the buyer's or government's perspective, the estimated cost must be compared to the benefit expected to be derived from the warranty in making the decision to buy the warranty.

Indeed, were warranty analysis merely a matter of tallying a list of costs and balancing them with the expected benefits, then the task of warranty evaluation would be a trivial one. One of the challenges inherent in warranty cost-benefit analysis is translating into dollars seemingly unquantifiable characteristics of a weapon system's operational and support performance. The warranty model or methodology must " . . . capture [the] essential economic, operational and statistical features. These will vary by contract, by item, by use environment and doctrine, and by a host of other factors as well" (1:6-24). The task quickly takes on Herculean proportions. As a result of the incredible complexity involved in warranty analysis, no single, universal warranty evaluation model is currently available (1:6-24). Instead, there exist as many models as there are types of warranties and items warranted.

In summary:

> . . . the methods available for estimating warranty costs are not really any different than those used for estimating other types of costs. However, the real difference in the warranty area is that there is a great deal of emphasis being placed on estimating costs [when]

the data base required for this is seriously lacking (16:18).

At a conceptual level, warranty cost-benefit analysis involves the comparison of benefits and costs associated with the subject warranty in an effort to make " . . .the best choice from a number of warranty alternatives" (16:15). (One alternative, of course, is choosing not to buy a warranty shown to be non-cost-beneficial.) Consequently, three basic methods of estimating warranty costs and benefits form the foundation of the majority of cost-benefit analyses. These methods are classic cost estimating methodologies, not peculiar to warranty cost evaluation, and include the "rule of thumb" or "heuristic" approach, the "cost-estimating relationship" (CER), and the "bottom-up accounting method" (16:15).

The "rule of thumb" or "heuristic" approach to the estimation of costs in general, and warranty costs in particular, involves establishing the relationship between one cost element and another. For example, one rule of thumb commonly used to estimate the cost of a new home relates the cost to the living space measured in square feet. Ideally, this approach would be supported by historical data, but often a rule of thumb is based only on experience and intuition. Consequently a rule of thumb can be useful in the face of a limited or non-existent data base. However, the user must remember this approach will yield only a rough, order of magnitude approximation of the subject cost element (11:74; 16:16).

The second methodology available for the estimation of warranty costs and benefits is the Cost Estimating Relationship (CER). The CER is a statistically based parametric relationship between warranty cost and some other variable or variables, and consequently, is more rigorous and potentially accurate than the heuristic. The development of a CER is a complicated and involved process that depends on the existence of an extensive historical data base. Once developed though, a CER can yield more accurate cost estimates than those generated heuristically. One other significant liability associated with the CER also stems from its grounding in historical data. A CER will only be valid in the analysis of warranty costs for systems whose technology is similar to that represented in the historical data base. A CER cannot be applied with any degree of fidelity to systems exploiting technologies radically different than those captured in the available data base (11:74; 15:3-9, 4-6; 16:16-17).

A third underlying methodology of warranty cost estimation, the bottom-up accounting method, attempts to capture every cost element that comprises the total cost of the warranty. Such an approach offers the potential for the most accurate warranty cost estimates. It relies heavily on historical data as well as an ability to accurately forecast future costs. Consequently, the effective use of a warranty model based on a bottom-up accounting method will be hampered by non-existent historical data, or inaccurate forecasts. Further, a bottom-up accounting methodology that captures cost elements generated via heuristics or CER will yield forecasts no more accurate than the weakest estimate it includes (11:74; 15:4-9; 16:17).

In summary, the preponderance of warranty evaluation tools available today capitalize on one of these cost estimating approaches. As indicated, warranty cost estimation is not markedly different than the forecasting of other types of costs. But effective warranty cost estimation requires types of data that are not widely available, the quantification of cost elements that defy translation to dollars and cents, and the ability to accurately forecast future costs. Consequently, warranty cost estimation is difficult, and the art and science of warranty evaluation has only recently received the attention that will ultimately result in the development tools useful to the acquisition agencies and source selection activities.

WARRANTY EVALUATION TOOLS

The following warranty evaluation tools typify the methodologies now emerging to assist the program office in its cost-benefit analysis of weapon system warranties.

USAF RIW Model

A Reliability Improvement Warranty (RIW) is a specific type of warranty " . . . intended to provide the contractor with an incentive to improve equipment reliability during its operational life" (12:5). Not all warranties, not even all reliability warranties attempt this. Some merely warrant the maintenance of a specified level of reliability performance. But the Air Force became an early proponent of this particular type of warranty when commercial air carriers attributed their success in procuring reliable aircraft equipment to the RIW. So, in the early 1970s the Air Force began trial applications of the RIW in selected weapon system acquisitions.

The USAF RIW Pricing Model, then, was developed to evaluate this one specific type of warranty, the RIW. It has since been used to establish an independent warranty price estimation prior to the receipt of contractor bids (15:33). The model was built on a bottom-up accounting methodology (described earlier) which collects costs in four broad categories: Fixed Direct Costs, Other Yearly Costs, Costs per Return, and Data and Administration costs (15:3-3 to 3-4).

The advantages inherent in this model are those associated with any bottom-up accounting methodology. The RIW Pricing Model offers tremendous potential for accurately forecasting costs. Also, once it has been developed, the model can easily assess " . . . the effects of changing system performance parameters and warranty/guarantee provisions" (15:3-9). Flexibility and potentially great fidelity, then, are characteristics of the USAF RIW Pricing Model.

Likewise, the RIW Pricing Model cannot escape the disadvantages associated with the cost estimating methodology at its foundation. These stem from insufficient historical data and the risks inherent in forecasting future costs, reliabilities, and repair rates beyond the initial few years of a system's life (15:3-6). Such forecasts can be only as good as the supporting historical data base and the fidelity of contractor cost estimates.

Product Performance Agreement Center Decision Support System

The Air Force Product Performance Agreement Center (PPAC), located at Wright-Patterson AFB, Ohio, has developed a computer-based model to help the program manager better cope with the intricacies of weapon system warranties. The PPAC Decision Support System (DSS) is an interactive computer program that aids the program manager in the selection of system parameters to be warranted, the optimization of warranty type and structure, and the cost-benefit analysis of warranties. The cost-benefit analysis module can be used to estimate government warranty costs, contractor costs, and the expected life cycle costs and savings inherent in the warranty (7:4-3).

The cost-benefit analysis module requires extensive data on predicted weapon system performance, support system performance, and planned system operations. For example, data on weapon system performance is required at the Line Replaceable Unit level (LRU, an individual component within an aircraft subsystem) in order to use the model. For example, the user of the DSS must already know the expected number of failures and removals for each LRU, as well as the number of manhours that will be required to fix it.

This requirement for extensive, detailed information severely limits the application of this model. Such data is simply not available as early as the source selection phase of a weapon system which will employ new technology, or current technology integrated in a new way. Also, the trend in weapon system acquisition is toward system-level performance specifications and warranties. Here, the government is less concerned with the performance of each individual piece of a weapon system. It is the overall or system-level performance of the weapon that really matters. Under such a system-level performance specification, the contractor is left with the latitude to select (within certain constraints) whatever mix of LRUs will result in the weapon system performing at specified values. Consequently, during source selection it is unlikely that either the government or the contractor will know the complete complement of LRUs that will ultimately comprise the whole weapon system. As a result, the corresponding LRU-level data is unknown and unknowable.

Warranty Analysis Model (WAM)

The Warranty Analysis Model (WAM) represents an important stride in the direction of useful, usable warranty evaluation tools. WAM's developers recognized the application of a warranty evaluation tool should optimally occur during the early stages of the weapon system acquisition cycle (e.g., source selection), but " . . . will require implementation without the availability of detailed equipment and operating scenario characteristics" (2:3). As discussed earlier, the realization that some warranty evaluation models require information that is simply not available during the source selection stage is an important first step in the creation of a useful model. Accordingly, WAM incorporates a two stage evaluation process. First, a qualitative step screens out sub-systems and equipment that are not natural candidates for warranty protection. This initial screen compares a candidate's performance characteristics to a " . . . list of warranty evaluation criteria," in order to yield " . . . a qualitative determination of suitability" (2:5).

The second stage of WAM subjects the surviving warranty candidates to a parametric economic analysis to determine " . . . the incremental differences in expected life cycle acquisition and operating and support costs due to incorporation of the [warranty] program" (2:1).

As with the USAF RIW Pricing Model, WAM is optimized for the analysis of one specific type of warranty, the RIW. But the WAM modelers have allowed for the tailoring of WAM to accommodate other types of warranties in that " . . . the methodology can be used with or without the reliability growth module" (2:2).

WAM is packaged in the form of an interactive computer program and requires only " . . . standardized input data elements which are available early in any product design process" (2:7). The model's output is in the form of " . . . detailed listings of the expected acquisition, warranty and operating and support costs" for a range of warranty periods and life cycles (2:7).

These models typify the state of warranty evaluation research. The bottom line is there exists no off-the-shelf methodology a program manager can readily apply to the crucial determination of whether or not a proposed weapon system warranty is cost-beneficial. Given this background, the following chapter examines the nature of the AC-130U Gunship warranty and the cost-benefit analysis methodology developed for its evaluation.

Chapter Four

AC-130U WARRANTY PROVISIONS
AND
COST-BENEFIT ANALYSIS MODEL

The following describes the specific warranty provisions designed into the AC-130U contract. These provisions were included in the Request for Proposal which solicited proposals from many contractors. Contractors were required to price each element of the warranty and provide their pricing rationale. The Gunship Program Office entered formal source selection with proposals from three prime contractors.

The latter half of this chapter describes the cost-benefit model which was developed by the Gunship Program Office and tailored specifically to analyze the prime contractors' warranty price proposals.

AC-130U WARRANTY PROVISIONS

The planned mission of the AC-130U system and the projected cost of designing, developing, and building twelve Gunships meant the program was bound by the provisions of the Defense Procurement Reform Act (i.e., its projected cost exceeded both the $100,000 per unit limit and the $10 million total procurement cost limit). The Gunship legally required a cost-beneficial warranty. In order to comply with the Reform Act, the program developed provisions that corresponded to the three required warranties referenced in Chapter 2: Design and Manufacturing, Material and Workmanship, and Essential Performance warranties. Each of these is discussed below.

AC-130U Design and Manufacturing Warranty

The Gunship Design and Manufacturing Warranty stipulates the contractor will warrant:

> For a period of two years after acceptance of the aircraft or a period of two years after completion of Interim Contractor Support . . . whichever is later, that [the weapon system] will conform to all design and

> manufacturing requirements specified in this contract (including but not limited to all specifications and statements of work), and in any amendments thereto. Design and manufacturing requirements include, but are not limited to, all structural and engineering plans and manufacturing particulars, including, but not limited to, precise measurements, tolerance, materials, processes and finished product tests for the item being produced (9:2).

In other words, this provision requires the contractor to warrant that the engineering design and the manufacturing processes he employs to produce the hardware comply with the specifications in the contract. It covers characteristics of the weapon system such as " . . . size, weight, interfaces, power requirements, and material composition" (3:2-3). The Gunship Program Office added a unique feature to this warranty in its description of the warranty's duration.

The Program Office recognized the necessity and desirability of a period of Interim Contractor Support (ICS) for the Gunship. During this time, the contractor would be responsible for maintaining the aircraft and making any engineering design changes required to maintain compliance with the specification. These design changes might entail replacing Gunship components or subsystems, which would likewise result in changes to the associated support and test equipment, training and training equipment requirements. The Air Force would then use this interim period to methodically build-up its organic support capability for the Gunship only as the design of the weapon system matured and stabilized. The objective in keeping this warranty in effect for two years beyond the end of the ICS period was to ensure that during ICS the contractor would make design changes that truly addressed the cause of performance shortcomings. From the Program Office perspective, a contractor would be more likely to institute quality, lasting fixes knowing his responsibility for system performance continued well into the future.

Material and Workmanship Warranty

The Gunship Material and Workmanship Warranty requires the contractor to warrant:

> For a period of one year after acceptance of the aircraft or a period of one year after completion of Interim Contractor Support . . . whichever is later, that the [weapon system] . . .[is] free from all defects in materials and workmanship (9:2).

As in the case of the Design and Manufacturing Warranty, this clause is "standard" with the exception of the innovation on the part of the Program Office to establish the link to the ICS period. This warranty targets a system's latent defects, or those defects that " . . . exist at the time of acceptance by the Government but [do] not manifest [themselves] until sometime after acceptance" (3:2-1, 2-5).

Essential Performance Warranty

The warranty that proved the most challenging in development, and required the most innovation and foresight, was the Essential Performance Warranty. A system's essential performance characteristics are those operational aspects required of the system in order for it to successfully perform its intended mission. A significant constraint in choosing essential performance characteristics is the extent to which that parameter is already measured in the field. The selection of a characteristic which is routinely and accurately measured and reported by the user is desirable and will help to minimize the cost (both in terms of dollars and inconvenience) associated with monitoring the chosen parameter.

Accordingly, the Gunship Essential Performance Warranty requires the contractor to warrant (9:2):

> For a period of two years after acceptance of the aircraft or a period of two years after completion of the Interim Contractor Support . . . whichever is later, that the [weapon system] will conform to the essential performance requirements . . . specifically delineated in this contract and in any amendments thereto. For the purposes of this warranty, the essential performance requirements are delineated as follows:
>
> Navigation System Accuracy
>
> (A) Inertial Navigation System: 0.8 NM/hr Circular Error Probability (CEP) for first hour without position updates; 0.65 NM/hr without position updates from one to ten hours.
>
> (B) Global Positioning System: 15 meters CEP and 20 meters Spherical Error Probability.
>
> Fire Control: [Note: Classified; not included in this paper.]
>
> Reliability: 1.1 Flight Hours, Mean Flight Hours Between Unscheduled Maintenance (MFHBUMA).
>
> Maintainability: 2.6 Hours Mean Time to Repair (MTTR).

These three major provisions, then, fulfilled the mandate of the Weapon System Warranty Act and the Defense Procurement Reform Act. Coincidental to the crafting of these AC-130U Gunship warranty provisions, the Program Office also developed the following warranty evaluation methodology.

AC-130U COST BENEFIT ANALYSIS METHODOLOGY

Purpose

The AC-130U cost-benefit analysis model was developed to answer two questions:

1. Were the proposed warranties cost effective?
2. Which proposal was the most beneficial to the Air Force?

In answering the first question the Program Office would know the status of its compliance with DFARS Subpart 46.770 and the Defense Procurement Reform Act. Could we place a proposed warranty on contract as is, or would it require modification to make the warranty cost beneficial to the government?

The second question, which assumed two or more cost beneficial warranty proposals, would provide additional cost data on which to base the selection of the winning contract. So, the cost-benefit analysis served the source selection in two valuable ways. First, it would alert the source selection committee to a contract unawardable on the basis of a non-cost beneficial warranty. Secondly, the cost-benefit analysis would serve as a discriminator between competitive contract proposals.

Methodology

The fundamental methodology upon which the cost-benefit analysis model was built was a comparison of the life cycle costs the government could expect to incur in owning and operating the AC-130U over the course of its service life both with and without the proposed warranty. Specifically, the AC-130U Cost Benefit Analysis sought to compare the cost of each offeror's warranty with the marginal costs the Air Force would incur without a weapon system warranty. Our original intent was to employ a bottom-up accounting methodology to aggregate the cost elements involved. Consequently, the major effort associated with the development of the model was determining the most accurate source or basis for estimating each category of cost that would comprise the total life cycle cost of the AC-130U.

While some categories of costs were well documented and could be accurately estimated, others were more elusive, their estimates mere educated guesses. For example, the fuel consumption of the C-130H (the basic airframe on which the AC-130U would be built) is known, and the cost of JP4 is relatively stable (8:8, 19, 22). So, barring some future energy crisis, the cost of fuel over the life of the Gunship is easily and accurately estimated. On the other hand, what is the cost of missing an intended target? It is certainly more than the cost of the expended round. An almost infinite and largely unquantifiable litany of indirect costs comes to mind:

Opportunity Cost: By "wasting" the round, what other targets go unscathed, and what would have been the value in neutralizing them?

Needless Exposure to Enemy Threat: Does the "miss" result in additional time over target and increased exposure to ground fire?

Unintended Collateral Damage: What did the round actually hit? Did we injure or kill friendly forces, or damage their equipment?

Continued Effectiveness of Intended Target: The target is still operational, possibly inflicting damage to friendly forces.

It soon became apparent that certain categories and types of costs would evade our best attempts at forecasting them accurately. Indeed, one rapidly approaches a point of diminishing return in pursuit of the "perfect" cost estimate.

So, through a rough trial and error process we accepted certain costs as relevant and relatively easily and accurately estimable. At the same time other costs were rejected either because they were not relevant, or though relevant, were too hard to accurately forecast.

Ground Rules and Assumptions

Throughout this trial and error process, we were forced to establish a set of ground rules and make certain assumptions in order to make the CBA manageable given our limited manpower and time. These assumptions allowed us to "bound" the problem, and are illustrative of the obstacles encountered during the CBA.

a. Warranty Period. Though not specifically addressed in the contract, we assumed the warranty would begin with the Air Force acceptance of the first aircraft. The warranty would then remain in effect through the ICS period and end six months, one year, or two years after the termination of depot level ICS (all three scenarios were examined as part of a sensitivity analysis). The end of ICS was set at the end of CY93 for all offerors, regardless of individual delivery and ICS schedules, although individual delivery schedules provided the number of aircraft in the warranty period (9:9).

b. Post-Warranty Period. We assumed all corrective actions initiated under the warranty would be completed prior to the expiration of the warranty. Furthermore, the aircraft were assumed to operate within specification tolerances up to the warranty expiration (9:9).

c. Deficiency Remedies. We assumed any deficiency covered by the warranty (e.g., Design and Manufacturing) would be corrected by means of a Class 4 modification in both the "with" and "without" warranty cases. (A Class 4 modification is implemented to achieve acceptable levels of safety, overcome mission capability deficiencies, improve reliability or reduce maintenance costs, all deficiencies that our warranty was designed to cover (8:3). The rationale for this assumption is central to the cost-benefit analysis. The alternative to the permanent "fix" of a Class 4 modification, some kind of temporary, work-around measure, invariably results in increased logistics support of the ailing system. In other words, instead of correcting the cause of the deficiency, the logistics system provides a "band aid" in the form of increased stockage of spare parts, providing additional maintenance man-hours, cannibalizing good systems, hiring full-time contractor "tech reps", or various other means. Over the life cycle of a weapon system, the cost of such work-arounds can be enormous. However, an assumption basic to the cost-benefit analysis was the Air Force would insist system performance remain within specified contractual values whether a warranty was purchased or not. Consequently, the Air Force would opt for a Class 4 modification to correct a deficiency with or without a warranty on Gunship system performance (9:9).

d. Flyaway Costs. The estimated flyaway cost for each proposal excluded the cost of the government furnished equipment (GFE) (that equipment the government had agreed to make available to the contractor as part of his system integration effort). Consequently, the cost of the entire C-130H airframe, which the Air Force would provide the winning contractor as GFE, was not included in the forecast flyaway cost (9:10).

e. Government Warranty Administration Costs. These are direct and indirect costs the Air Force incurs in managing the warranty, i.e., ensuring and documenting compliance with the terms and conditions of the warranty. Typical warranty administration costs include system performance tracking and reporting, maintenance documentation and review, vendor contact, and preparing and reviewing status reports. In the case of the Gunship, we deliberately structured the warranty to minimize the costs of its administration. For example, one criteria for the selection of Essential Performance Characteristics was the performance parameter chosen would not require the imposition of any reporting procedure over and above normal Air Force maintenance reporting procedures (5;6;9:10).

Scope

Initial iterations of our cost-benefit analysis model were considerably more ambitious and comprehensive than the version we finally applied. At the start, we intended to capture all relevant costs that comprise a weapon system's life cycle cost and calculate the impact (savings) a comprehensive system warranty would have. It became readily apparent that a project of that magnitude was beyond our capability and time allowed. After all, this cost-benefit analysis effort was an ancillary duty of a small group of program management and functional personnel whose main task was the conduct and management of a major weapon system source selection. So, the final version of the cost-benefit analysis model reflected a series of suboptimizations based on our limited pool of manpower, lack of cost-benefit analysis expertise, and the short time involved.

We finally settled on a version of the model that captured only the cost of the Class 4 modifications the Gunship would likely require to maintain specified contractual performance during the early years in the field. AFR 173-13 provided an accepted algorithm for estimating Class 4 modification costs (8:128). That algorithm coupled with specified and contractor-advertised system reliability parameters provided us a "neat," if narrow view of the marginal value of a proposed warranty.

In sum, our cost-benefit analysis methodology compared total Class 4 modification costs to the price of the proposed warranty for alternative warranty period lengths to isolate the marginal costs. The marginal costs would indicate whether a proposed warranty was cost-effective or not.

Application

The Gunship warranty cost-benefit analysis was conducted during the formal source selection process, the purpose of which was to award a contract for the Full Scale Development and Production of the AC-130U Gunship to one of three competing contractors. The Program Office, and other functional personnel conducting the source selection, performed a separate series of analyses on each competing warranty bid. This was necessary since each contractor generated a unique set of input data based on his estimates of such factors as system and sub-system reliability, frequency of repair, cost per repair, cost for spares, training, and technical manuals, to mention only a few. The resulting estimated warranty cost for each contractor was compared to the Air Force's independent estimate of the cost of providing organic maintenance. The difference was then a measure of each warranty's cost-beneficiality. The estimated warranty cost was also included in the overall forecast life cycle cost of each contractor's weapon system. Consequently, the warranty cost-benefit analysis counted heavily in the source selection.

The Cost Panel of the source selection organization worked independently to derive the bottom line life cycle cost for each contractor's bid. As a rule, no other functional sub-set of the source selection activity is granted access to the cost data. However, the Cost Panel relied heavily on technical advice and inputs from the groups performing the technical evaluation of the bids--engineers, logisticians, safety people, and operators. In this way the costs ultimately assigned to the operation and support of the Gunship received technical validation.

The cost-benefit analysis relied heavily on data requested of each contractor as part of his proposal. Various factors worked against the timely transmission of this vital information. (See Chapter 5) As a result, in-house cost estimates were substituted for contractor inputs in a few instances.

The warranty analysis resulted in the determination that one contractor's warranty was cost-beneficial to the Air Force, while the others were not. Another product of the warranty evaluation effort was a series of sensitivity analyses that provided the Source Selection Authority the relative costs and benefits associated with each warranty for various lengths of time. The objective here was to provide the final decision-maker the necessary information to optimize the contracted warranty.

In sum, the three main AC-130U warranty provisions covered Design and Manufacturing, Material and Workmanship, and Essential Performance Requirements, as required by the Weapon System Warranty Act and the Defense Procurement Reform Act. Of the three, the Essential Performance Requirements provision required the greatest vision and innovation. Also, the AC-130U Gunship warranty cost-benefit analysis methodology complied with the intent of the two enactments. While the cost-benefit analysis was a pioneering effort, as confirmed by the GAO report cited in Chapter 2, it exhibited certain shortcomings discussed in the next chapter.

Chapter Five

ANALYSIS OF AC-130U WARRANTY COST-BENEFIT ANALYSIS

Obviously there were faults in the Gunship cost-benefit analysis. Clearly there were costs and savings associated with the weapon system warranty other than those we captured. But the fact that the AC-130U Gunship Program Office made an honest attempt to conduct the cost-benefit analysis at all deserves recognition. After all, the GAO report cited in Chapter Two indicated that AC-130U warranty analysis effort was indeed exceptional. Nevertheless, the following analysis of the strengths and weaknesses inherent in our cost-benefit analysis is offered in the hope that future analyses are even more comprehensive and accurate.

STRENGTHS

The underlying strength of the Gunship cost-benefit analysis was its grounding in Life Cycle Cost (LCC) theory and analysis. The methodology was developed and the analyses were performed by LCC analysis experts.

Another significant strength of the cost-benefit analysis effort was the validation applied to the cost estimates from the functional experts. As the model was developed, logistics, engineering, and operational experts were interviewed in an attempt to validate the performance, support, and operational scenarios captured in the model, and in an attempt at translating performance parameters into costs and benefits measurable in dollars.

Finally, the foresight that characterized the development of the basic warranty provisions as well as the warranty cost-benefit analysis methodology was a noteworthy attribute. The Program Office recognized the two processes had to occur simultaneously. In the case of the essential performance requirements provision, the weapon system attributes identified as essential would influence the evaluation scheme, which would, in turn, dictate the information necessary to conduct the cost-benefit analysis.

The strengths of the AC-130U warranty cost-benefit analysis methodology were indeed noteworthy. Its shortcomings were perhaps even more instructive.

WEAKNESSES

The fundamental shortcoming of the Gunship warranty cost-benefit analysis was the narrow scope of its final version. Ideally, the analysis would have embraced many more of the costs associated with operating and supporting the weapon system covered by the three warranties: Design and Manufacturing, Material and Workmanship, and Essential Performance Requirements. However, ultimately we were constrained to an over-simplified comparison of Class 4 modification costs because of our inability to quantify and forecast such costs as:

1) The cost of the system not firing accurately. What are the costs of missing the target? Certainly more than just the cost of another round. Other costs that would have to be considered and quantified include: increased risk to the Gunship due to extended time-over-target; additional wear and tear on the weapon system; risk to friendly ground forces stemming from failure to destroy intended target with first shot; etc. ad infinitum.

2) The cost of an inaccurate navigation system. What are the costs of failing to position the Gunship along the intended route? The risk of over-flying hostile anti-aircraft weapon positions; the risk of alerting the enemy as to the Gunship's position and subsequently jeopardizing the mission; reduction in time-over-target resulting from inefficient enroute navigation. Again, the possibilities are almost endless, and the decision as to which should be included is as difficult as the process of forecasting and quantifying these costs.

3) The cost of the system performing below the specified values of reliability. Here again, the possible costs to be considered are seemingly infinite. For example, the costs of a system or subsystem malfunctioning or failing sooner than expected might include the cost of subsequently achieving the desired reliability by adding redundant systems, the risk of not achieving the intended mission due to equipment failure, the risk of losing the weapon system resulting from the failure of critical equipment.

4) The cost of the system performing below the specified values of maintainability. Examples here include: the cost of additional unplanned maintenance manhours required to maintain the system; the cost of increased

down time for the Gunship; the cost of additional special test equipment required to support the system.

These examples illustrate the monumental task of "costing" just one of the three Gunship warranties, the Essential Performance Requirements warranty, and explain why we opted to estimate these costs with a surrogate measure. Certainly the surrogate we chose, the forecast cost of Class 4 modifications, would capture pieces of each of these costs. But the resulting cost estimate was at best a rough, order of magnitude measure.

Another difficulty with the cost-benefit analysis was its dependence on data that ultimately was unattainable or non-existent. One important intended source of data was the contractors bidding on the Gunship contract. The government's Request for Proposal and Instructions to Offerors (documents used to solicit contractor bids, and to describe the format and types of information required in the contractors' bids, respectively) required the contractor to separately break-out the costs associated with each piece of his warranty. In addition, the government requested a description of the methodology employed to generate the contractors' warranty cost estimates.

The responses to these data requests were dismal. In fact, repeated requests for this information throughout the source selection process yielded data of only marginal usefulness. During face-to-face negotiations with each competing contractor midway through source selection, the explanation for this lack of responsiveness became apparent. One contributing factor stemmed from the contractors' misunderstanding of the purpose and requirements of the Gunship warranty. But more significantly, like the government, the contractors were unable to accurately forecast the cost elements associated with the type of warranties the government had crafted. The contractors had nothing that remotely resembled a rigorous methodology for estimating the warranty costs. The cost estimates these major defense contractors ultimately provided were gross approximations based more on intuition than analysis.

Also conspicuous in its absence was the necessary historical data on the government side. For example, in an attempt to verify the cost factors we applied in our forecast of Class 4 modifications over the life of the Gunship, we attempted to locate historical records of the Class 4 modification history of other similar systems. Unfortunately we discovered that the Air Force does not track such data. Without such historical data, estimating future performance and costs is a difficult task.

A third weakness inherent in the Gunship cost-benefit analysis was the set of assumptions on which it was ultimately based. Due to the paucity of analytical tools and historical data available, we were forced to bound the Gunship cost-benefit analysis methodology with certain unrealistic assumptions. One assumption with enormous potential for invalidating the government's warranty cost estimates was related to our linking of the ICS phase with the start of the warranty period. The Program Office hypothesized that the contractor would less likely apply patchwork, stopgap fixes to performance specification deviations encountered during ICS knowing that his responsibility for system performance extended well beyond the ICS phase.

Such thinking may prove optimistic; the assumed benefits have never been proved. Conceivably, the linking of ICS and the warranty period may have very little effect on the quality of engineering changes. Accordingly, the Gunship cost-benefit analysis may have over-estimated the true value of contractor engineering changes. Other assumptions like this one may have unduly constrained the Gunship cost-benefit analysis effort, but were necessary to compensate for our inability to simulate and forecast so many unknowns.

Also, the assumption that during ICS and the subsequent warranty period the contractor would be inclined to implement Class 4 modifications instead of temporary work-arounds may ultimately prove overly-optimistic and naive. The potential ramifications in this scenario are significant. The impact on the AC-130U Gunship logistics support system in terms of increased down-time and turn-around time, increased spare parts requirements, etc., would quickly outstrip any expected warranty benefits.

In sum, the AC-130U Gunship warranty cost-benefit analysis effort was a good, honest, pioneering effort. Clearly though there is considerable room for improvement. The final chapter draws conclusions and offers recommendations for improving this crucial process.

Chapter Six

CONCLUSIONS AND RECOMMENDATION

CONCLUSIONS

It is now a legal requirement for DoD acquisition agencies to contract for cost-beneficial warranties on the performance of the weapon systems they procure. Consequently, cost-benefit analyses must be performed in order to ensure the government procures only cost-effective warranties. However, warranty cost-benefit analysis is a new art. There exists no extensive body of knowledge on how to conduct an effective warranty cost-benefit analysis. In spite of the enormous impact this crucial decision-making process can have on the efficiency and effectiveness of the nation's weapon systems, there are very few useful warranty evaluation tools available today.

Some warranty evaluation tools are beginning to emerge. For reasons explored earlier, none of these are suitable for use in a source selection environment. The ramifications are potentially serious. The assertion has been made that " . . . the actual implementation of warranty programs has been held back . . . [by] . . . the lack of appropriate existing analytical tools" (2:3). The longer the government fails to contract for effective weapon system warranties, the longer we face the prospect of acquiring weapon systems that perform at a level below their potential.

A significant inadequacy of the existing models is their requirement for information about the performance characteristics of a weapon system far in excess of what is realistically available or which can be accurately forecast. This is especially true for those methodologies that build upon a bottom-up accounting approach to cost estimation. For a weapon system that exploits new technology, or one that integrates existing technology in a new way, or for a contract written on a system-level performance specification, that data is simply not available in the source selection phase of a program.

A second reason why existing models do not lend themselves to use during the source selection process is the effective use of these models requires extensive cost-benefit analysis expertise or expertise in the manipulation of rigorous mathematical models. As sophisticated as the typical Air Force program office is, that kind of expertise is not likely to reside there.

Third, these models seldom enjoy universal applicability. Each has been developed to analyze a specific type of warranty. Consequently, they cannot be readily tailored for use with other forms of warranties.

The AC-130U Gunship Program Office encountered each of these obstacles in the development and implementation of its warranty cost-benefit analysis methodology. That methodology was the end product of a series of compromises and suboptimizations stemming from these roadblocks. Consequently, it was clearly not an optimal warranty evaluation scheme.

RECOMMENDATION

The DoD must provide the impetus for the design and development of useful warranty analysis tools. The type of tool most useful to a program manager in the source selection environment would be simple and flexible, and should not require extensive data on the future performance of new systems for which no historical data base exists. The warranty cost-benefit analysis tool should not require great expertise in cost-benefit analysis, mathematical modeling or computer science. It should be designed for the typical program manager or his Deputy Program Manager for Logistics.

The development of useful and accurate warranty cost-benefit analysis tools will require considerable dedication and effort. But considering the importance of the decision at hand, and the crucial missions of the weapons in question, there is no doubt the effort must be made.

BIBLIOGRAPHY

A. REFERENCES CITED

Published Proceedings

1. Department of Defense/Federal Acquisition Institute, Proceedings of the Ninth Acquisition Research Symposium (Annapolis, MD: n.p., 1980), pp. 6-21 to 6-28.

2. Society of Logistics Engineers, Proceedings of the 13th International Logistics Symposium (St. Louis, MO: n.p., 1978), pp. 4:55-63.

Official Documents

3. Defense Systems Management College. Warranty Handbook. Fort Belvoir, VA, June 1986.

4. US Department of Defense: Federal Acquisition Regulation. Washington D.C., April 1984.

5. US Department of the Air Force. Equipment Maintenance, Maintenance Data Collection System (MDC). AF Manual 66-267 (Ph IV). Washington DC: Government Printing Office, 1984.

6. US Department of the Air Force. Maintenance Management Policy. AF Regulation 66-1. Washington, DC: Government Printing Office, 1983.

7. US Department of the Air Force: Product Performance Agreement Center. Product Performance Agreement Guide. Wright-Patterson AFB, OH, November 1985.

8. US Department of the Air Force. US Air Force Cost and Planning Factors. AF Regulation 173-13. Washington, DC: Government Printing Office, 1986.

9. US Department of the Air Force: "Warranty Cost Benefit Analysis, AC-130U Gunship." Source Selection report. Wright-Patterson AFB, OH, May 1987.

10. US General Accounting Office: "Improvements Needed in Implementation of Warranty Legislation." Draft of a proposed report. Washington D.C., February 1987.

Unpublished Materials

11. Bielling, Deborah A., Captain, USAF. "The Feasibility of a Cost-effectiveness Assessment of Air Force Jet Engine Warranties." Master's thesis, Air Force Institute of Technology, Wright-Patterson AFB, OH, September 1986.

12. Bizup, Joseph A. and Moore, Randall R. "Techniques for Selecting and Analyzing Reliability Improvement Warranties." Unpublished researach report no. R7505, Naval Weapons Engineering Support Activity, Weapon Systems Analysis Department, Washington D.C., 1975.

13. McNease, Jiley E., Captain, USAF. "Case Study of the Application of the Weapon System Warranty on the C-130 Program." Master's thesis, Air Force Institute of Technology, Wright-Patterson AFB, OH, September 1986.

14. Savage, Robert W., Lieutenant Commander, USN. "Aviation Warranties: The Costs and Risks." Master's thesis, Naval Postgraduate School, Monterey, CA, 1985.

15. Tom, Kenneth B. Analysis of Warranty Cost Methodologies. Technical Report No. 3243-01-TR-3504. Department of the Navy, Washington, D.C.: Naval Material Command, January 1985.

16. Van Der Stelt, Jay L., Captain, USAF. "The Feasibility of a Cost-effectiveness Assessment of Weapon System Warranties: A Case Study of the F-16 Reliability Improvement Warranty (RIW) Program." Master's thesis, Air Force Institute of Technology, Wright-Patterson AFB, OH, September 1986.

CONTINUED

B. RELATED SOURCES

Unpublished Materials

Blatchley, Peter A., Captain, USAF. "The Evaluation of Reliability Improvement Warranties." Unpublished research report, Air Force Institute of Technology, Wright-Patterson AFB, OH, May 1984.

Frank, Deborah F. "Cost Effectiveness Analysis, Night Vision Warranties." Comptroller, Cost Analysis Division, Fort Monmouth, NJ, April 1987.

Rich, Michael. "Improving the Military Acquisition Process." Technical Report No. R-3373-AF/RC. Rand, Santa Monica, CA, February 1986.

END
DATE
FILMED
6-88
DTIC