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Major avionics subsystems for candidate aircraft developed under the Design-to-Cost (DTC) acquisition concept were analyzed to gain additional insight into the critical production cost goal-setting process. The candidate aircraft sample consisted of the Air Force F-16 and A-10, the Navy F-18, and the Army Advanced Attack Helicopter (AAH). A total of 23 avionics subsystems assigned to the candidate aircraft were investigated.

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It was found that only six of the 23 subsystems met Department of Defense criteria for authentic DTC programs. The other subsystems were developed and acquired by airframe prime contractors on a competitive fixed-price basis with priced options for production. In these programs, competitive pricing replaced DTC goal-setting.

Based upon the limited research findings, it was concluded that subcontractor goal-setting was usually masked by competitive pricing practices; the resulting development programs did not have the schedule, cost, and design tradeoff flexibility to properly pursue the cost goal. It also was concluded that the goal establishment process, as observed for those six subsystems examined in the study, was effective and did include appropriate important criteria for goal selection. Final conclusions relating to goal establishment were (a) the absence of life-cycle cost goals did not appear to impact the production cost goal selection, (b) competitive pricing was not an effective methodology for realistic goal-setting, and (c) without OSD or Service policy guidance, inconsistent application of goal-setting criteria and inconsistent cost goal implementation for similar type systems are likely to continue.

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ON SETTING AVIONIC SUBSYSTEM UNIT PRODUCTION COST GOALS

C. David Weimer

October 1977

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COST ANALYSIS GROUP

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PREFACE

During the past five years, the author has conducted research studies in the application and implementation of new electronics systems and subsystems acquisition policies. The focus of much of the research has been upon the translation of policy philosophy and guidance into practice. These efforts often involved examining specific programs in an effort to understand the mechanics of policy application as well as identify the barriers to implementation.

Common to many of the findings is the fact that basic policy premises are not always present or realizable in actual practice. Thus, for Design-to-Cost (DTC) programs, the basic premises of competitive development and demonstration, development schedule flexibility, design performance flexibility, and "difficult but achievable" cost goals were subject to critical examination. Except for the cost goal, these basic DTC premises were often found to be absent; and when they were, program difficulties with policy implementation arose.

Cost goals for DTC programs were not given the research attention merited primarily because, except for a few isolated cases, the goals did not appear to be a problem area. Most contractors reported they felt the goals were well defined and, with proper effort, could be achieved. As the major DTC electronics subsystems moved into the procurement phase and fixed-price multi-year contracts were negotiated, the prices negotiated for the equipment provided visible evidence of successful cost goal achievement.

There was one disturbing aspect to the negotiated production unit prices, however. All of the prices, achieved through negotiations between competing contractors, ranged between twenty and thirty percent below the unit production cost goals measured in constant-year dollars.[1]

These events raised several questions about the original cost target or goal. Was the goal realistic? Did the goal consider advances in technology that would result in cost savings? Was the goal really difficult to achieve given the outcomes documented? Were program changes responsible for the goal and price discrepancy? Was the goal realistic but incompatible with the pressures of competitive pricing and the practice of a "best and final" price bid? Answers to these questions would be hard to find and document; a beginning at achieving an insight into the goals would be an investigation into the critical goal-setting process whereby the goals were initially established.

Many DTC electronics systems and subsystems previously analyzed were not developed separately by the Government, but were (or are presently) being developed under a subcontract from a major prime contractor. For further insight into the goal-setting process, it seemed important that the origin of the cost goals for these programs also be investigated.

Greater insight into the goal-setting process appears to be warranted if there is to be increased confidence in the validity of future design cost goals. If future goals are "difficult but achievable," contractors will be motivated and innovative during development to produce designs that meet the goals. If goals are set at easily-achievable levels and production award price competition ensues, the benefits of DTC

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[1]The reader is referred to, C. D. Weimer, *An Assessment of Goal Achievement for the Initial Electronic Subsystem Design-to-Cost Experiments*, IDA Paper, P-1239, December 1976.

policies are lost during development and the conditions for cost growth enhanced. Gaining confidence in the realism of the goals, as well as their difficulty, will permit the Government and their contractors to focus on the demanding problems of maintaining acceptable performance and providing improved field reliability and maintainability.

Given these findings and observations, the Assistant Director of Defense Research and Engineering (planning), directed the Institute for Defense Analyses (IDA) to proceed with a limited research evaluation of the critical cost goal setting process. This direction resulted in IDA Task T-140, included in this paper as Appendix A. This paper summarizes the results of this directed effort.

The author wishes to thank the members of the technical review board, Ms. Geraldine Asher, Mr. Jack Hockett, Mr. Raymond Kendall, and Mr. James McCullough for their helpful criticisms and suggestions throughout the course of this research project.

EXECUTIVE SUMMARY

Major avionics subsystems for candidate aircraft developed under the Design-to-Cost (DTC) acquisition concept were analyzed to gain additional insight into the critical production cost goal-setting process. The candidate aircraft sample consisted of the Air Force F-16 and A-10, the Navy F-18, and the Army Advanced Attack Helicopter (AAH). A total of 23 avionics subsystems assigned to the candidate aircraft were investigated.

It was found that only six of the 23 subsystems met Department of Defense criteria for authentic DTC programs. The other subsystems were developed and acquired by airframe prime contractors on a competitive fixed-price basis with priced options for production. In these programs, competitive pricing replaced DTC goal-setting.

For those programs where DTC goal establishment occurred, the criteria for selecting a specific cost target included the cost of existing equipment, cost estimates based on prototype equipment, independent estimates, OSD direction, and projected budget affordability. Potential equipment contribution to the total system mission value (mission worth) was not considered in any of the subsystems examined.

Life-cycle cost targets were not explicitly established for any of the candidate programs. However, life-cycle cost estimates were used extensively to compare design alternatives and in some cases for evaluating production cost goals.

Unit production cost goals were found to be set in the early stages of the development process, usually before initiation of the engineering development phase. In all cases, the Service program manager was the final authority for the cost goal value. Since DoD and Service policy guidance were deficient in specifying the process of goal establishment, each program manager established his own methodology for arriving at a unit equipment cost target.

Based upon the limited research findings, it was concluded that subcontractor goal-setting was usually masked by competitive pricing practices; the resulting development programs did not have the schedule, cost, and design tradeoff flexibility to properly pursue the cost goal. It also was concluded that the goal establishment process, as observed for those six subsystems examined in the study, was effective and did include appropriate important criteria for goal selection. Final conclusions relating to goal establishment were (a) the absence of life-cycle cost goals did not appear to impact the production cost goal selection, (b) competitive pricing was not an effective methodology for realistic goal-setting, and (c) without OSD or Service policy guidance, inconsistent application of goal-setting criteria and inconsistent cost goal implementation for similar type systems are likely to continue.

I

INTRODUCTION

During the past six years, the Department of Defense (DoD) has pursued a Design-to-Cost (DTC) weapon system acquisition concept. Since its initiation by Deputy Secretary of Defense David Packard, in 1971, DTC has been applied to most major weapon system acquisitions and many "less-than major" systems and subsystems. Concurrently, the DTC concept has been institutionalized through DoD directives, implementing memoranda, and application guidelines.

In theory, the DTC concept is simple. Cost is to be considered a design parameter equal in weight to performance parameters. The critical design and development process is to be structured to continually focus upon both cost and performance goals, employing tradeoffs where necessary, to achieve a balanced design that will accomplish the intended mission at an affordable cost. The design is thus intended to be a product of the two key parameters, cost and performance.

It was recognized early in the development of the DTC concept that total system life-cycle costs must be considered in the design rather than just future unit production costs. However, difficulties associated with the measurement of both current and future operational costs led early applications of the DTC concept to consider only unit production cost as a design parameter; performance specifications of equipment reliability and maintainability, if achieved, would effectively help to limit operational costs acquired by the system in field use. Thus, the first applications of the DTC concept were called "price-limited prototypes."[1] Production unit price (or cost) became the principal cost design parameter.

When future unit production costs joined equipment performance (including reliability and maintainability) as primary design parameters, a number of significant changes were created in the system or subsystem development process. New design concepts had to be evaluated for future production cost impact, design iterations to meet both cost and performance goals were initiated, and development test and performance validation programs became more complex. At the subsystem level, future cost estimates of manufacturing labor, purchased parts and materials became critical to the design process, increasing cost estimating and reporting activities by contractors and their suppliers.[2]

The imposition of production unit cost as a design parameter had wide ranging effects. Every functional element of the product development program was affected and the relationships between prime contractors and their subcontractors or material vendors became key channels of cost-performance tradeoff information. Previous research has shown that cost goal introduction in the design-to-cost acquisition process also resulted in changes to contractor corporate policies and procedures, their organizational structure, and their cost management systems.[3]

Given the potential as well as observed impact that the introduction of production cost goals have upon system and subsystem development, it is obvious that the cost goal or target

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[1]Department of Defense Memorandum, John S. Foster to Assistant Secretaries of the Military Departments, *Development of Price Limited Prototypes*, 10 July 1972.

[2]A typical example of DTC requirements for major subcontractors is contained in this report as Appendix B.

[3]The reader is referred to C. D. Weimer, *The Application of Design-to-Cost Acquisition Policies to Selected Electronic Subsystem Development Programs*, S-459, Arlington, VA.: Institute for Defense Analyses, June 1975.

is a very important parameter to both the design of the end product and the conduct of the supporting development program. It is to be expected that the level or magnitude of the cost target therefore would have a direct effect upon both the system design and the development program. If the goal represents a real challenge to both the technology and the management of the development program, large impacts would be expected. However, an easily achieved goal would not present any significant impact; design and development would proceed as though there were no cost threshold and management-by-exception would suffice for periodic cost control.

Recognizing the key role that the production cost goal occupies in properly conducted design-to-cost programs, the Institute for Defense Analyses (IDA) undertook a limited task to investigate the process of cost goal establishment, with primary emphasis upon the identification of guidelines and methodologies for cost goal establishment in the early development stages.[1]

Since the majority of the early design-to-cost development programs were directed toward avionics equipment, the scope of the task was narrowed to avionics equipment associated with either the air-to-air or air-to-ground tactical aircraft missions.

The specific tasks for the study were as follows:[2]

1. Investigate newly developed Air Force, Army, and Navy tactical aircraft and derive a list of candidate mission avionics having design cost goals suitable for analysis.

2. For each avionics candidate, determine within the constraints of time and data availability the history and related facts concerning the equipment cost target or goal, including the identification of methodology, alternatives considered, participants, and decision criteria.

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[1]A copy of the IDA task order is included as Appendix A.

[2]*Ibid.*

3. Based upon the data acquired and the experiences of the Services, formulate guidelines for future goal establishment and propose candidate methodologies to be considered for cost goal quantification.

The basic approach to execute the tasks was to select candidate systems and subsystems appropriate for analysis and then proceed to acquire Government and contractor data that would permit analysis of the DTC goal establishment process. As a first step, the mission avionics associated with newly developed Service tactical aircraft (also having DTC goals) were identified and examined for subsystem design-to-cost goals. From the derived list of avionics with cost goals, a number of candidate subsystems were selected for further analysis.

Concurrently with candidate subsystem selection, the policy guidance and candidate program events relating to cost goal establishment were obtained through literature research and numerous field interviews with Service and contractor participants in the goal-setting process. A total of 38 separate interview meetings were held during the 90 day data-gathering period.

The analysis of the acquired data consisted of the categorization of goal-setting criteria, methodology, process variables, participants, and other information resulting from the research. These findings were synthesized for conclusions leading to recommendations and operating guidelines for cost goal-setting.

It is recognized that several important limitations attended the study. The time for the field research was limited to approximately 90 days which prevented an in-depth study of any single candidate system. During the investigations into the history of some candidates, it was found that historical details of the goal-setting process were simply no longer available and that records documenting key decision criteria had been destroyed. Many of the programs examined had been managed by a succession of Government program managers and their industrial counterparts during the past six to ten years; personnel currently associated with the programs did not participate in the original goal-setting process and therefore could not provide details of the goal-setting experiences or supporting rationale. These limitations also precluded the recovery of sufficient data to support specific and detailed recommendations for goal-setting methodologies as requested by task 3 of the IDA task order.

Recognizing the above limitations, the research study was pursued in an attempt to gain a greater insight into the goal-setting process. Specifically, insight into the answers to the following questions was sought:

1. What criteria was utilized in establishing the goals?
2. When were the goals established?
3. Who participated in the goal-setting?
4. What differences exist between systems and subsystems?
5. Have the previously set cost goals been achieved?
6. What lessons-learned have been obtained from the goal-setting process?

Answers to these questions would lead to recommendations for establishing cost goals for future DTC programs.

This paper is organized according to the specific tasks described above. Chapter II provides background for understanding the goal-setting process and describes Department of Defense policy guidance for cost goal establishment. Chapter III reviews the candidate systems and subsystems considered for further analysis, leading to the selection of the final set of candidate equipment. Chapter III examines these candidates individually and in the aggregate for goal-setting methodology, participants, and decision criteria. For those programs which have entered the production phase, the outcome of the program in terms of unit production cost is compared with the original unit production cost goal. Findings derived from the data are presented in Chapter IV leading to conclusions and recommendations (Chapters V and VI) for future goal-setting.

II

POLICY GUIDANCE FOR COST GOAL SETTING

One of the first areas to be investigated was DoD policy guidance for production cost or life-cycle cost goal-setting. The purpose was to understand the guidance provided to those who were responsible for establishing the cost goals and thereby formulate a normative baseline or standard procedure that could be used to evaluate the candidate programs.

The policy geneology for cost goal-setting is essentially the design-to-cost acquisition policy history. Some elements of goal-setting are found in all of the policy directives and memoranda addressing design-to-cost. Because Service implementing memoranda generally reiterated the OSD policy guidance, the survey of policy guidance was limited to the OSD-generated guidance.[1]

A. DOD DIRECTIVE 5000.1

The first evidence of cost goal guidance is contained in DoD Directive 5000.1, dated 13 July 1971.[2] This policy states:

> *Cost parameters shall be established which consider the cost of acquisition and ownership: discrete cost elements (e.g., unit product in cost, operating and support cost) shall be translated into 'design to' requirements.*

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[1]Service implementing instructions took the form of transmittal directives, handbooks, and contractor-prepared guides. In the area of goal-setting, most of these directives were no more definitive than the original DoD guidance.

[2]Department of Defense Directive 5000.1, *Acquisition of Major Defense Systems,* 13 July 1971.

The directive is silent on further goal-setting details, criteria, or methodology.

B. PRICE-LIMITED PROTOTYPE DIRECTIVES

The next mention of goal-setting is contained in a DoD memorandum, dated 10 July 1972.[1] Addressing the development of price-limited prototypes, the new (design-to-cost) concept is described as differing from present practice "...by first establishing a unit production price at a level we can afford to pay...."[2] This is the first policy directive that established affordability as a principle criterion for setting the cost goal. The memorandum also contained a suggested list of candidate price-limited programs with initial estimates of production price goals. The Services subsequently were asked to respond with nominations of their own. From the text, it was not clear where these initial OSD estimates originated.[3]

The OSD candidate equipments are listed in Table 1 below.[4]

In a response to the OSD letter, the Army stated "The unit production price we plan to associate with each of these developments will be determined after careful study to obtain a realistic match of performance requirements, R&D and production technology and procurement funds expected to be available for these items."[5] For the Army, at least, these were the decision criteria for the first "price-limited" prototypes.

The guidance contained in the memorandum was not clear to many of the Service recipients. Primarily, their concerns centered around the difference between the "price-limited"

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[1]*Loc. cit.*, 10 July 1972 DoD Memorandum, *Development of Price-Limited....*

[2]Underlining is the author's.

[3]The memo leads the reader to believe the price goals originated within OSD.

[4]*Ibid.*, p. 3.

[5]U.S. Army Memorandum for Director of Defense Research and Engineering, *Development of Price-Limited Prototypes*, 19 September 1972.

Table 1. OSD NOMINATIONS FOR CANDIDATE ELECTRONICS PRICE-LIMITED PROTOTYPES

A.	An air-to-air combat radar with look-down capability which could be procured in quantities for about $200K equipment cost, and with a field reliability of around 100 hours.
B.	An inertial navigation system with accuracy of about 1 to 3 nautical miles per hour which could be procured in quantity for about $40K equipment cost, and with a field reliability of around 500 hours.
C.	A FLIR, with two fields of view, which could be procured in quantity for about $25K equipment cost, and with a field reliability of around 200 hours.
D.	An airborne TACAN which could be procured in quantity for about $10K equipment cost, and with a field reliability of around 1,000 hours.
E.	A tactical UHF command radio for airborne use which could be procured in quantity for about $5K equipment cost, and with a field reliability of around 1,000 hours.
F.	An airborne LORAN navigation system that could be procured in quantity for $80K equipment cost with a field reliability of around 400 hours for high performance aircraft; or one for $15K for helicopter use, with a field reliability of around 500 hours.

concept and the discredited "Total Package Procurement." In a subsequent memo dated 4 August 1972, H.D. Bennington of DDR&E clarified the Foster memorandum by explaining the differences in the two concepts.[1] The differences were defined as follows:

1. "The development program is done on a *cost plus* basis, and no production award is made until successful field testing is completed.

[1]Department of Defense, Office of the Director of Defense Research and Engineering, Memorandum for the Assistant Secretaries of the Military Departments, *Development of Price Limited Electronics Prototypes,* 4 August 1972.

2. The design is to a stated production price, with performance being flexible.

3. There is competitive development with a "fly-off for selection based on relative performance."

The memorandum continues to outline the DTC development process, stating that future production price is the fixed parameter, the one known. Continuing, the memo states "... when feasibility has been previously determined; when the development is cost-plus; when competition is present; and when performance is flexible, it may be desireable to tie the contractors down to an initial production buy at the specified unit price."

These clarifications and conditions for DTC programs are especially important for our study because as subsequently will be shown, many of the candidate programs did not contain these essential ingredients.

C. JOINT LOGISTICS COMMANDERS DESIGN-TO-COST GUIDE

The next policy document which treated DTC goal-setting was the Joint Logistics Commanders' "Design-to-Cost Guide" dated 3 October 1973.[1] The guidance contained in the guide calls for "...challenging but realistic unit production cost goals."[2] The guide further elaborates on the problem of matching cost goals with performance within limits of affordability. Explicit guidance for cost goal establishment is not addressed. The guide recommends forming a multi-discipline team to perform alternate and iterative system designs to arrive at a system concept which meets the operational need. Prior to DSARC I, the goal is to be set by the Service program manager and stated in the Decision Coordinating Paper (DCP). However,

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[1]Department of Defense, Joint Design-to-Cost Guide, Washington, D.C., Government Printing Office, 3 October 1973.

[2]*Ibid.*, p. 16.

these goals are not to become formal contractual goals in the validation phase until agreed upon by the contractors or in-house suppliers.

D. OSD DESIGN-TO-COST HANDBOOK

At the same time that the Joint Logistics Commanders were working on their guide, several officials within OSD were attempting to complement broad guidance through an OSD DTC Handbook.[1] Mr. Jacques Gansler, Assistant Director (DDR&E planning) was particularly active in this effort, which unfortunately never reached publication. Draft versions of the handbook showed that the goal-setting process was recognized as a critical first step. Here are the five suggested approaches toward establishing cost goals and the concluding comment in the goal-setting section.[2]

"Selecting Cost Targets"

> *Selecting reasonable cost targets is crucial to the Design to Cost process. There are a number of ways of doing this.*
>
> *The first way is to estimate the money available for a new system or item and divide by the quantities needed to determine the cost per copy. The second method is to relate unit costs to actual costs of existing systems. The lightweight fighter, for example, has a ceiling between the cost of the F-5 and the F-15, since the performance goals fall between. Parametric estimating illustrates this approach. The third method simply sets the cost of the new system or item at the cost of the system it will replace. This challenges designers to use new technology to improve performance at reduced costs. The fourth approach, possible in items of smaller nature, is to use industrial engineering type estimates of projected details of the item to arrive at an estimated overall cost. Lastly, informed judgement can and must also be used in all cases.*

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[1]DoD, Office of the Director for Defense Research and Engineering, Design-to-Cost Handbook, unpublished draft, October 1973.

[2]*Ibid.*, p. 12.

Within the fiscal constraints in the mission or sub-mission area, selection of target unit production and support costs (or approximations) is fundamental to the Design to Cost process. Although different alternatives for selecting cost targets were briefly discussed above, there is no easy answer. Fundamentally this decision is a function of quantity requirements, the need (nature of the threat to be countered and consequent minimum required performance requirements), and the funds likely to be available.

E. DOD DIRECTIVE 5000.28

In response to a demand from the Services and their contractors for an authorizing policy directive for DTC, OSD issued Directive 5000.28 on 23 May 1975.[1] This directive discussed four aspects of the goal establishment process as follows:[2]

(1) Cost objectives shall be established during concept formulation based upon an estimate of the resources available. A firm design-to-cost goal will be recommended whenever a cost associated with minimum acceptable performance can be estimated with confidence.

(2) The goal should be "difficult but achievable."

(3) The goal, to be included in the DCP, will be reviewed by the OSD Cost Analysis Improvement Group (CAIG) and the DSARC advised on its achievability.

(4) The goal shall be established before DSARC I or at the earliest practical date thereafter (but before DSARC II).

F. REVISED JLC DTC GUIDE

In June 1976, the JLC Guide was reissued, containing revisions which expanded the DTC concept to include life-cycle

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[1]Department of Defense, Office of the Secretary of Defense, Design-to-Cost Directive 5000.28, 23 May 1975.

[2]*Ibid.*, p. 6.

costs as well.[1] Ironically, the revised guide contained less guidance than the original edition on cost goal establishment methodology. This was left to DoDD 5000.28. The only guidance provided was that the goals should be "difficult but achievable" and should be relatable to life-cycle cost estimates supporting the DCP or budget submissions.[2]

During a discussion of program phases, the guide states that "...one of the outputs of the conceptual phase should be information sufficient to establish the system design-to-cost goals and targets..."[3] This approach implied that goals would be forthcoming as a result of the conceptual studies, usually performed by system or subsystem contractors. Thus, the guide does not provide specific guidance for goal-setting methodology. The guide is explicit in the content of the DTC goal and its utility and management throughout the acquisition process; however, the process of goal-setting is left to the Service program manager and the supporting in-house and contractor organizations.

G. SUMMARY OF POLICY GUIDANCE

The DTC policy guidance from 1971 to 1976 provided assistance in several areas of concern. The guidance was explicit in areas of goal content, the timing of the goal establishment (prior to DSARC I), the authority for the goal (the Service program manager), and source of goal analysis (concept definition studies). Several criteria for goal establishment have been forwarded. They include affordability (mentioned most frequently), and cost to achieve minimum acceptable performance. Except for mention of multi-discipline teams and concept definition studies, there was little guidance on exactly how the

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[1]Department of Defense, Joint Design-to-Cost Guide (Revised), June 1976.

[2]*Ibid.*, p. 23.

[3]*Ibid.*, p. 41.

goals would be established. It was clear that the intent was to make the goals "difficult but achievable," but there was little guidance as to how this goal characteristic was to be achieved. The Service program manager was given a great deal of freedom and flexibility in approaching the problem of goal-setting.

III
CANDIDATE AVIONICS SELECTION

In accordance with the task order, tactical aircraft from all three Services were examined to derive a list of mission avionics having design cost goals. Four candidate aircraft containing 23 major avionic subsystems were identified for further analysis. These systems and subsystems are listed below in Table 2.

Table 2. CANDIDATE DTC AIRCRAFT SYSTEMS AVIONICS SUBSYSTEMS

Service	Aircraft	Subsystem	Subsystem Contractor
USA	AAH Helicopter	TADS/PNVS[1]	Northrop/Martin Marietta
		Fire Control System	Rockwell International
		Fire Control Computer	Teledyne Systems
		Doppler Navigation System	Kearfott
		Altimeter	Honeywell
USAF	A-10 Aircraft	AHRS[2]	Lear Siegler
		Heads-Up Display	Kaiser
		Tacan	Republic
	F-16 Aircraft	Radar	Westinghouse
		Flight Control Computer	Lear Siegler
		Fire Control Computer	DELCO
		Inertial Navigation System	Kearfott
		Tacan	Collins
		Heads-Up Display	Marconi
		E-O Display Electronics	Kaiser
USN	F-18 Aircraft	Radar	Hughes
		Central Data Computer	CDC
		Inertial Navigation System	Litton
		Heads-Up Display	Kaiser
		Cockpit Display	Kaiser
		Altimeter	Honeywell
		Tacan	Hoffman
		Flight Control Electronics	GE

[1]Target Acquisition and Designation System/Pilot Night Vision System.

[2]Attitude Heading Reference System.

These aircraft were selected based upon the following criteria:

- major DTC system
- tactical mission aircraft

Each of the aircraft systems was subsequently investigated to determine if their subsystems were developed with design-to-cost goals. It was found that only six of the 23 subsystems had explicit design-to-cost goals.[1] Five of these subsystems were developed independent of the major prime contractors with contracts directly from the Government procuring agency.

Despite the fact that each of the aircraft examined was being developed under unit production cost goals, the prime contractors did not explicitly negotiate or set production cost goals for their avionics subcontractors.[2] The posture adopted by the primes was to negotiate with subcontractors fixed-price full-scale development contracts which contained firm option prices for initial and follow-on production quantities. The option prices set for production, as well as the fixed prices negotiated for the development program, were the result of competitive negotiations between the primes and competing subsystem subcontractors.

An investigation of several candidate subsystem development programs under fixed-price subcontracts was made to determine if significant differences existed between this mode of acquisition and theoretical DTC practices. This analysis revealed several key differences that prevented including these

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[1]The prime contractors claimed that most of their subsystems were being developed or produced to design-to-cost goals. However, further investigation demonstrated that these goals were in reality, fixed-price purchase agreements. The DTC process, outlined by OSD and DDR&E, had not been implemented at this second tier level of contracting.

[2]A distinction is being made between the cost goal setting as described by the OSD policy guidance and a fixed price set through competitive negotiations.

subsystems in the goal-setting survey. The goals (or contract price options) were not set by criteria such as affordability, mission worth, or cost to achieve minimum acceptable performance.[1] In general, the goals were prices resulting from strong competitive forces and based upon contractor pricing analyses of prototype models. The development program for the equipment was not executed with a pre-set production unit price as an explicit design parameter. Thus, the timing of the cost goal (price) establishment was after design rather than before. The Service program manager for the major weapon system also did not have direct goal-setting authority for the avionics equipment. This was delegated to the prime contractor who used subcontractor bids to develop subsystem goals. The prime contractor was obligated to manage the subcontracted avionics within his total prime contract avionics goal.[2]

The parallel between the relationship of a major aircraft prime contractor in a system design-to-cost program working with his avionics subcontractors is remarkably similar to that observed for an avionics prime contractor working with his major component suppliers.[3] The competitive market price becomes the design-to-cost goal for the second-tier subcontractors. These prices are usually not established prior to equipment design, although there could be an anticipatory relationship. Another similarity is that prime contractors prefer to purchase fully developed equipment where there is

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[1]The reader is referred to the ODR&E DTC program criteria described above on page 10.

[2]The Government program manager usually establishes subsystem DTC goals based upon his overall DTC target commitment outlined in the DCP. He may also trade-off among these goals without OSD or DSARC approval, depending upon the prime contractor estimates of their contractual success with subcontractors.

[3]More detail of this latter relationship is contained in *op. cit.*, C. D. Weimer, S-459, pp. 67-73.

confidence in the equipment design, performance and future price. Thus, for the candidate aircraft, it was found that many of the avionics subsystems selected had completed engineering development and, in some cases, were "off the shelf" equipment.[1]

Table 3, below, summarizes the avionics subsystems evaluated during the initial screening process. As shown, the six subsystems selected as appropriate for further DTC goal-setting analysis were the Army's AAH TADS/PNVS system, Doppler navigator, and altimeter; the Air Force F-16 radar and Tacan set; and the Navy AYK-14 airborne computer.

Each of the selected programs set DTC goals before engineering development commenced or during the early design phases. It is noteworthy that most of these programs also contained formal competition during development, and were developed under cost-type development contracts.

To the extent that project time and resources permitted, the goal-setting process of each of these six systems was investigated. The results of this effort and the experiences of the competing contractors will be addressed in Chapter IV.

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[1]Some equipment described as fully developed by the prime contractors was found by our investigations to be less than fully developed, still having significant technical problems to be resolved during full-scale development.

Table 3. SUMMARY OF CANDIDATE SUBSYSTEMS

Aircraft	Subsystem	Contractor	Unit Cost/ Target Price	OTC	Notes
Army	TAOS/PNVS	Northrop/Martin	$304,000	Yes	1,6
	Fire Control System	Rockwell Inter.	44,000	No	8
AAH	Fire Control Computer	Teledyne Systems	32,500	No	8
	Ooppler Nav. System	Kearfott	26,000	Yes	1,7
	Altimeter	Honeywell	3,500	Yes	1,7
Air Force A-10	Altitude Heading Reference	Lear Siegler	$ 25,000	No	2
	Heads-Up Oisplay	Kaiser	50,000	No	2,3
	Tacan	Republic	15,000	No	2
Air Force F-16	Inertial Nav. System	Kearfott/Singer	116,546	No	4
	Flight Control Computer	Lear Siegler	50,332	No	4
	Radar E/O Display	Kaiser	61,840	No	4
	Heads-Up Display (HUD)	Marconi	42,283	No	4
	Fire Control Radar	Westinghouse	250,000	Yes	1,9
	Fire Control Computer	Delco	69,106	No	4
	Tacan	Collins	10,000	Yes	1
Navy F-18	Fire Control Radar	Hughes	$276,000	No	5
	Inertial Nav. System	Litton	92,000	No	5
	Heads-Up Display	Kaiser	20,000	No	5
	Cockpit Displays	Kaiser	84,000	No	5
	Flight Control Electronics	GE	74,000	No	5
	Central Data Computer	COC	37,000	Yes	1,5
	Tacan	Hoffman	22,000	No	5
	Altimeter	Honeywell	3,500	No	5

1. Selected for further analysis.
2. Prices approximate; based upon analyses of Air Force budget documents.
3. Kaiser is a replacement contractor; original contractor encountered technical problems which could not be overcome.
4. Price data obtained from GO prime contract F-33657-75-C-0310, Attachment 11, undated.
5. Price data obtained from Navy F-18 point paper, F-18 avionics production estimates, March 1977.
6. Price data obtained from USA(ECOM) "AN/APN-209 Procurement Supporting Rationale," Memorandum ORSEL-UL-E, 14 May 1976.
7. Price data extracted from IDA Paper P-1239 "An Assessment of Goal Achievement for the Initial Electronic Subsystem Oesign-to-Cost Experiments," Oecember 1976.
8. Price data obtained from Hughes Helicopter Co. Internal OTC memorandum, dated 23 August 1974.
9. Cost goal reported by Defense Marketing Survey Report, December 1975. Previous cost goal of 220,000 was reported by the Air Force in ASO letter to prospective contractors "Air Combat Fighter, (ACF) Radar Program," 1 August 1974.

IV

COST GOAL-SETTING EXPERIENCES

This chapter reports the results of investigations into the six candidate subsystems. While primary emphasis will be given to the origin of the cost goal, the programs that have gone into production also will be documented for cost goal achievement.

A. ARMY APN-209 ABSOLUTE ALTIMETER

In 1972, the Army recognized a future requirement for a solid-state absolute altimeter that could be adapted to planned rotary-wing aircraft such as the AAH in the 1975 to 1985 time period. After evaluating existing commercial and military altimeters, the Army decided that no existing commercial system would adequately satisfy Army needs for low-level night operations or be affordable in large production quantities.[1] Informal and unsolicited communications with altimeter manufacturers indicated that the proposed mission requirements were achievable and that a production unit price ranging from $3,000 to $4,000 (1972 dollars) was feasible. A Material Need (MN) document was drafted, a request for Approval of a Class Determination and Findings (D&F) was prepared, and preparation for a Request for Technical Proposal (RFP) was subsequently initiated in mid-1972.

During these preparations for solicitation, the Army received the OSD (DDR&E) memorandum requesting candidates for

[1]Both acquisition costs and operational costs of current altimeters were higher than could be afforded.

price-limited prototypes.[1] In response, the Army selected the absolute altimeter as one of two experimental price-limited candidates with a target cost goal of $3500 in FY 1972 dollars.[2] The cost goal was based upon a match of performance requirements, R&D and production technology, and procurement funding expected. A total quantity of 2,000 units was planned.

The Army arrived at the cost goal through engineering estimates of pre-development prototype systems, vendor budgetary quotations, and affordability analyses. However, confidence that this goal was reasonable came only after solicitations had been sent to prospective contractors and five proposals were received, each agreeing to undertake development of the altimeter with a "not-to-exceed" production unit price of $3,500.

Two development contractors, Hoffman and Honeywell, were selected in November 1973 for parallel nineteen month development and demonstration programs. Hoffman, however, was forced to withdraw from the competition because of their inability to provide demonstration test models producible within the cost goal.[3] In September 1976, after successfully completing the development program, Honeywell and the Army negotiated a production contract at a unit price four percent below the DTC goal.[4]

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[1]*Loc. cit.*, 10 July 1972 Memorandum, *Development of Price Limited Prototypes*.

[2]The other system was a Forward Looking Infra-Red (FLIR) sensing system, originally suggested in the DDR&E Memorandum. This program was delayed by technical difficulties and subsequently was dropped from the candidate list.

[3]Department of Defense, U.S. Army Electronics Systems Command, Letter DRSEL-VL-E, *APN-209 Procurement Supporting Rationale*, 14 May 1976.

[4]For additional cost goal achievement details see C. D. Weimer, *An Assessment of Goal Achievement for the Initial Electronic Subsystem Design-to-Cost Experiments*, P-1239, Arlington, VA.; Institute for Defense Analyses, December 1976.

For this program, the unit production cost goal was set by the Army program manager before engineering development commenced and as a direct response to the OSD DTC policy memorandum. The target value was established based upon potential contractor cost estimates, affordability considerations, and cost analyses of demonstration prototypes. The goal was demonstrated to be "difficult but achievable" when one of two competing contractors was not able to meet the goal and withdrew from the competition. The other contractor (Honeywell) successfully delivered development prototypes that met all minimum performance parameters and accepted a production contract slightly below the unit price goal.[1]

B. ARMY ASN-128 DOPPLER NAVIGATOR

The second program with an established DTC goal was the Army's AAH ASN-128 Doppler Navigator, also developed by ECOM. This system was designed to be a lightweight, low-cost, highly reliable navigation subsystem suitable for both rotary and fixed-wing aircraft in the 1977-1980 time period.

The background for the procurement was influenced by a continuing requirement for a lightweight and low cost navigation system coupled with unsatisfactory operational cost and maintenance experience with a previous model, the ASN-64.[2]

In the fall of 1970 and spring of 1971, it was determined by a survey of industry that significant technical breakthroughs in Doppler navigation systems were being accomplished, particularly in solid-state electronic components. Subsequent to this determination, industry sources again were solicited to participate in a test and evaluation program. This evaluation

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[1]Honeywell actually could have reduced their price further but, with the Army's endorsement, improved equipment performance at the DTC goal level.

[2]Department of Defense, Department of the Army, Advanced Procurement Plan, *Lightweight Doppler Navigation Systems*, 25 September 1973.

program was initiated in February 1972 with three companies participating--Teledyne Ryan Aeronautical Company, Canadian Marconi, and Singer-Kearfott Company. An assessment of the demonstration models indicated that the technology was now developed to the point where it was feasible to proceed directly into engineering development. In 1973, the Army program manger conducted a study to determine what the ceiling production unit price should be for the subsystem.[1] As a result of this study, a DTC goal of $25,100 was established for the navigator subsystem (LDNS) and $9,500 for the direct reading display subsystem for a quantity of 1,000 units. Costs were fixed in FY 1974 dollars. The unit cost study was conducted with the help of the ARINC Research Corporation. The cost goals were confirmed through engineering estimates of the prototype configurations produced and tested by the three competitors. It should be noted that the DTC goals were comparable to the existing prices of the ASN-64 equipment that was to be replaced ($37,870).[2]

In 1974, engineering development contracts were awarded to two competing contractors, Teledyan Ryan and Singer-Kearfott. After both contractors successfully completed the development program, Kearfott was awarded the production contract in January 1977 for a price substantially below the cost goal in FY 1974 dollars.[3]

As in the Army altimeter program, the DTC goals were based, at least partially, upon engineering analyses of prototype

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[1]Department of Defense, Department of the Army, Electronic Systems Command, *Lightweight Doppler Navigation Subsystem (LDNS) Engineering Development Cost Estimate*, Study #7, September 1973.

[2]Department of Defense, Department of the Army, Electronic Systems Command, *Advanced Procurement Plan: Lightweight Doppler Navigation Subsystem*, 25 September 1973.

[3]U.S. Army, Electronic Systems Command Memorandum DRCPM-NC-PF, AN/ASN-128 Cost Data and Schedule, 4 January 1977.

designs. Affordability and current similar system costs were additional considerations. The DTC goal was set early and was specified in the RFP for the engineering development program.

C. ARMY AAH TADS/PNVS SYSTEM

The Army AAH helicopter development contract specifies an overall DTC goal of $1,556,000 per aircraft in FY 1972 dollars.[1] The major AAH electronics/avionics subsystem is the Target Acquisition and Designation System (TADS) combined with the Pilot Night Vision System (PNVS). These subsystems have a contractually stipulated DTC goal of $304,000 in FY 1972 dollars.[2]

Currently (1977) two contractors, Martin-Orlando and Northrop, have competitive engineering development programs to produce development demonstration models. This program was preceeded by a conceptual development program under which Hughes Aircraft Corporation conducted basic design studies for both major airframe competitors, Hughes and Bell. Hughes Aircraft did not have a contractual DTC goal for their studies. However, they were required to submit documentation and rationale for their earlier cost proposal at the conclusion of their design tasks.[3]

Discussions with Hughes Helicopters, the successful competing prime contractor, their subcontractors, and members of the Government project office revealed that, once again, the DTC subsystem goal was set by the program manager. The basis for the goal was initially one of affordability within the

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[1]Department of Defense, Department of the Army, Aviation Systems Command, Contract DAAJ01-77-C-0064, January 1977, p. 12.

[2]*Ibid.*

[3]Purchase order R60679 from Bell Helicopter Co. to Hughes Aircraft, Attachment 1, Section VI, *DTC Requirements,* 28 August 1974.

overall AAH DTC target of $1,556,000 per helicopter. Government analyses established a budget for the major subsystems, i.e., airframe, communications, navigation, fire control, armament, etc. Within cost bandwidths of affordability, proposals from competing contractors were evaluated and cost targets were selected by the Army for each of the major subsystems.[1] Because of the competitive nature of the program, specific details of these various cost proposals or the decision criteria for the TADS/PNVS cost goal were not available for this analysis.

The AAH TADS/PNVS is the first of two subsystems investigated (the other is the F-16 Radar) which was dependent upon and designed specifically for a single weapon system. We found that the major system DTC goal established affordable boundaries on the subsystem goals and that the subsystem goal was derived by the Government project manager based upon industry proposals and his in-house technical and cost analytical staff. When final RFPs were issued, the DTC goal had been set and bidding contractors were considered non-responsive if their designs were priced above the cost target.

D. AIR FORCE ARN-118 TACAN

The first formal Air Force DTC program in response to the new policy initiatives was the development of a Tacan receiver-transmitter which would have high reliability (1,000 hr. MTBF) and low cost (less than $10,000 each).[2] Dr. John Foster, Director, DDR&E, described the program as "...the USAF model program for the DTC concept."[3]

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[1]Not only were cost goals established but anticipated reductions in unit cost as a function of quantity in the form of "learning curve" factors were specified. For example, the navigation subsystem was to achieve an 80 percent learning curve and the fire control subsystem a 90 percent learning curve.

[2]Mean Time Before Failure (MTBF).

[3]Department of Defense, Director of Defense Research and Development, Memorandum for the Assistant Secretary of the Air Force (R&D), *Low Cost, High Reliability Tacan,* 30 June 1972.

Goal-setting research for this program revealed that authority for development of a new Tacan was initiated 3 April 1970 with an approved Determination and Finding (D&F 70-11C-92). The D&F described a two phase development program leading to the production of a "light-weight, low cost, and highly reliable" Tacan. At this time there was not specific mention of the unit cost goal.

The first instance of goal-setting for the program was found in the work statement negotiated with two contractors, ITT Avionics Division and Collins Radio, for Phase I feasibility studies. Each contractor was to study the feasibility of a "...state-of-the-art primary Tacan receiver-transmitter unit having an MTBF of 1,000 hours at a procurement cost of less than $10,000."[1]

Each of the Phase I contractors reported in May 1971 that it was feasible to design and produce a Tacan for less than $10,000 based upon initial buys of 500. Collins responded by stating that the proposed equipment could be produced for less than $10,000.[2] ITT Avionics estimated that the new Tacan could be manufactured for $9,200 each as new installations and $9,400 each as retrofit units in 1971 dollars.[3]

Based upon the results of the feasibility studies, the D&F was updated in early 1972 to specify a $10,000 unit cost goal for production options of 50 to 500 sets. A formal design-to-cost goal of $10,000 for production quantities of 500 or

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[1]Work Statement "A", *Contract Definition for Airborne Tacan,* Contract F33657-71-C-0315. The goal was not linked to a specific year dollar value.

[2]Collins Radio Company, *Tacan Feasibility Study Report,* No. 523-076-3832-0011M, Cedar Rapids, Iowa, 9 June 1977. Collins did not state a specific cost estimate value.

[3]ITT Avionics Division, *Final Report: Feasibility Study Contract Definition Phase for Hi-Rel, Low-Cost Airborne Tacan AN/ARN-107,* Nutley, N.J., May 1971. The increased cost for retrofit units was attributable to adapter units needed to complete the retrofit.

radar is being procured under contract by General Dynamics, Fort Worth Division, in a manner similar to the other F-16 avionics.[1] Under the criteria accepted for this study, this program would not have qualified as a true DTC candidate.[2] However, the background of the Westinghouse F-16 radar does contain many of the elements of goal-setting and except for the manner of contracting, is an interesting example of cost goal establishment. The F-16 radar is reported to have a design cost goal of $250,000 in 1974 dollars (quantities to support 1388 aircraft).[3]

Westinghouse's effort was initiated in 1971 as a result of a Defense Science Board[4] study focusing on the high costs and poor reliability attendant to avionics systems developed in the 1960s. As a result of this study, Westinghouse (as did their competitors) attempted to find ways through advanced electronics technology and system architecture to reduce fire control radar costs and improve system field reliability.

A group within Westinghouse was formed to consider what action could be taken about the problem of rising avionics costs. The group considered the market potential and state-of-the-art advancements in radar technology. The conclusion was reached that a substantial reduction in the cost of fire control radars could be achieved without sacrifice of essential performance capabilities.

Initial meetings of the Westinghouse group to consider the design and development of new fire control radars were

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[1]A fixed-price contract for development with firm option prices for initial production quantities.

[2]Particularly the criteria that development be cost reimbursable in order to achieve cost goals and that the goals not be set by price competition.

[3]Cost goal reported by Defense Marketing Survey Report, December 1975. Previous cost goal of 220,000 was reported by the Air Force in ASD letter to prospective contractors "Air Combat Fighter, (ACF) Radar Program," 1 August 1974.

[4]The Fubini Defense Science Board Avionics task force.

were held in the summer of 1971. One of the first tasks was to establish prices. It was decided early that achieving major cost reductions could best be accomplished with a number of radars, each aimed at a particular mission requirement. Through the use of the modular approach and digital techniques much similarity could be maintained, thus the idea of a family of closely related radars evolved.

A survey of market potential for various mission requirements indicated that a large share of the air-to-air fighter fire control requirements could be met with a pulse Doppler, all-aspect radar with lookdown capability and mission-oriented range performance. Based on considerations of past radar design, development cost, and production cost together with cost reduction gains resulting from new digital techniques, it was concluded that a radar with the needed capabilities could be built to sell in the mid 1970s for an average price of $200,000 for a lot of 500.

In late 1971, approval of Westinghouse Corporate Headquarters in Pittsburgh was received for the investment of $5 million of internal funds to support the design and development of this new family of radars. Effort on the new radars proceeded on high priority and the first of the WX-200 radars was completed on schedule in August 1972.[1]

Key to the design philosophy of the Westinghouse family of radars was the establishment of a price substantially below that of comparable radars then available. Primary considerations in the design philosophy other than price were significantly increased reliability and maintainability, while maintaining minimum acceptable performance. To accomplish these objectives, it was decided to use the modular approach with autonomous

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[1]WX is the corporate securities symbol for Westinghouse. WX-200 designated a radar which would be priced at approximately $200,000 each in production lots of 500.

elements that would enable meeting various mission requirements without the need for complete redesign and development for each system. Digital techniques were used extensively to meet the computing and signal processing requirements that are subject to change when updating the mission. This was a major factor in achieving desired system performance with improved reliability and maintainability yet maintaining system growth capability within manageable cost limits.

The F-16 radar was a direct outgrowth of the WX concept. It represented a slightly more sophisticated capability than was envisioned for the WX-200 series. However, without the design effort which focused on cost as the primary limiting design variable, it is doubtful that the radar capability could have been obtained for the cost.

Once again, it is important to note that the contractual arrangement Westinghouse has with General Dynamics is not substantially different than earlier programs, i.e., firm fixed-price development with priced options for production.[1] General Dynamics, in a manner similar to the other aircraft primes examined in this study, is managing a total system DTC program through firm subsystem commitments from the major subcontractors.[2] The key difference in this candidate case study is that the basic design of the prototype equipment, and subsequently the developed subsystem, evolved from a cost goal design discipline that produced the original DTC design which subsequently was adapted to the F-16. Unlike the other systems, the cost goal was established by OSD and the contractor rather than the Service program manager. The timing of the goal was,

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[1]General Dynamics letter of Solicitation #086-0069, *Request for Proposal (RFP 74-12) for F-16 Fire Control Radar,* 15 May 1975.

[2]A copy of the DTC requirements from the RFP referenced above is included as Appendix B. As shown, these requirements are detailed and comprehensive, despite the fact that the contractual arrangement is a fixed price purchase order.

like the others, early in the development process. And the basis for the goal included affordability, present equipment cost, market pricing, and technological impact on costs.

F. NAVY AYK-14 STANDARD AIRBORNE COMPUTER

Early in 1973, the Navy completed studies that indicated a need for a standard airborne computer for the 1980s and beyond. In addition, these analyses showed that 12 major airborne weapon systems would be committing to the development and purchase of airborne computers between 1975 and 1980. As a result, the Chief of Naval Materiel directed in August 1973 that the Navy pursue development of an "Interim Standard Airborne Digital Computer" (ISADC).[1]

The ISADC computer was to be based upon the use of modified off-the-shelf hardware and software and would serve the applications in the near term, including the Light Airborne Multipurpose System (LAMPS) helicopters and the F-18 aircraft. Two computers would be installed in each F-18.

By December 1974, the Navy had completed a proposed development plan, a user survey, and in-house budgetary estimates. As a result of the in-house estimates, unit production cost goals were established as a function of quantity, as shown below in Table 4.[2]

Based upon these estimates, a unit production cost goal of $37,000 was established for the computer.[3]

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[1]Department of Defense, Department of the Navy, Memorandum from Chief of Naval Materiel to Tactical Digital Systems Office, *Interim Standard Airborne Digital Computer,* 3 August 1973.

[2]Costs are based upon a 36 bit computer with a 16K word memory.

[3]The baseline year for the cost goal was not specified.

Table 4. UNIT PRODUCTION COST ESTIMATES FOR THE AYK-14 COMPUTER

Number of Production Units	Average Unit Production Cost
10	$70,000
100	45,000
500	37,000
3,000	33,000

Source: Naval Air Systems Command, ISADC Project Plan, December 1974, p. 3-14.

This DTC goal was negotiated as part of a development contract for 150 pre-production models with Control Data Corporation (CDC) in the fall of 1976.

Current (1977) requirements for the F-18 aircraft call for one 32K and one 64K memory computer. This requirement change has altered the DTC goals for these computers to $33,000 and $40,000 respectively for a quantity between 800 and 1,000.[1]

The original DTC goal for the AYK-14 was the result of in-house Navy estimates based upon similar equipment, parametric estimates, and contractor proposals. This goal was carried through the proposal and source selection process to form the basis for subsequent cost-performance adjustments.

The motivation behind development of ISADC and subsequent advanced standardized computers is primarily the reduction of operating costs and inventory costs resulting from recent airborne computer proliferation. Unit production costs did

[1]Department of Defense, Department of the Navy, Naval Air Systems Command Point Paper for the F-18, March 1977.

not represent an order-of-magnitude decrease in cost over other contemporary units. Therefore, the selection of the cost goal was based primarily upon the reasonableness of competitive prices for design configurations that were adaptable for standard usage.

G. SUMMARY OF COST GOAL EXPERIENCES

The experiences of six avionics subsystems examined during the study illustrate characteristics of the process of setting DTC goals, the timing of the goal establishment, the participants in the process, and the program outcome.

1. DTC Goal-Setting Processes

Six bases for choosing the DTC goal were identified during the investigations. They were (1) the cost of equipment to be replaced, (2) engineering cost estimates by independent contractors or Service cost estimating organizations, (3) contractor-conducted engineering estimates based upon their prototype equipment, (4) projected future budgetary affordability, (5) competitively priced contractor cost proposals, and (6) OSD or Service mandate. It was found that most programs employed several of the above criteria during the course of the development programs to set the ultimate cost target. A summary of the candidate programs and the goal establishment bases is shown in Table 5.

2. Cost Goal Timing

In all the programs examined, the average unit production cost goals were established prior to the beginning of the engineering development phase. In the case of the Tacan and the F-16 radar, the cost goals were established at a stage comparable to the beginning of a concept formulation phase.

Table 5. GOAL-SETTING BASIS FOR CANDIDATE PROGRAMS

System	Cost of Present Equipment	Independent Cost Estimates From Conceptual Designs	Contractor Cost Estimates From Equipment Prototype	Contractor Proposals	Service Affordability	OSD Service Direction
APN-208 Altimeter		X	X	X	X	X
ASN-128 Doppler	X	X	X			
AAN TADS/PNVS				X	X	
ARN-118 Tacan	X	X		X		X
F-16 Radar	X		X	X	X	X
AYK-14 Computer		X		X		

3. Goal-Setting Participants

We found many participants in the goal-setting process. In the Government, OSD and Service staff participated as did the program office and the procuring command cost analysis support staff. Goal-setting participants outside the Government included independent analysis organizations such as ARINC Research Corporation and industrial firms who were potential suppliers of the future equipment. The equipment contractors were found to occupy a central role in the goal-setting process, providing continuity throughout the successive phases of program initiation as well as being the primary source of cost estimates for conceptual designs.

4. Program Outcome

Three of the candidate programs have progressed into production and all three have achieved their average unit production cost goal in constant year dollars. A summary of these program outcomes is presented in Table 6.

Table 6. SUMMARY OF COST GOAL ACCOMPLISHMENT

System	Production Quantities	DTC Unit Cost Goal	Base Line Year	Production Contract Price	Goal Price Variance (%)
ARN-118 Tacan	500	$10,000	1970	$ 6,787	-32
APN-209 Altimeter	2,000	3,500	1972	3,414	- 3
ASN-128 Doppler (LONS only)	1,000	25,100	1974	18,958	-24

The differences between the cost goal and the negotiated unit prices are interesting. Two programs, the Tacan and Doppler navigator, were negotiated at unit prices substantially below the DTC target. The altimeter program was negotiated at essentially the pre-set target.[1]

It is not known why the goal-price variances existed for two of the three subsystems. Plausible explanations include the fact that production contract competition drove the final prices down (there was no parallel competition for the altimeter production negotiations), utilization of advanced electronics technology made greater cost savings possible than originally estimated, or the goals for these two programs were set at a level which was not difficult to attain.[2]

There is evidence, documented by the Army program office, that additional performance, above the absolute minimum essential to mission success, was added to the Honeywell altimeter without breaching the cost goal.[3] The system development

[1]These are not isolated examples. Other DTC subsystem programs have experienced the same outcome when competition was present. The Air Force ARC-164 UHF radio and the ARN 131 Omega receiver, both production and life-cycle cost-constrained, were negotiated at unit production prices 25 percent below their pre-set cost goals in terms of constant dollar values.

[2]An assumption that is perhaps in error is that the production contract prices represent the actual cost to produce the equipment plus an acceptable profit.

[3]Department of Defense, Department of the Army, Electronics Systems Command Memorandum DRSEL-VL-E, 14 May 1976.

concept in this case could be described as the achievement of maximum performance (including reliability and maintainability) at an affordable and pre-set unit production price. If this additional performance had not been added (or if competition was present during negotiations for the production contract), it is likely that a lower price would have been negotiated for the production units.

In the case of the Tacan and the Doppler, both competitors' equipment met minimum essential performance parameters; the production award therefore was made on the basis of lowest cost or price to the Government.

V
SUMMARY OF FINDINGS

Several key findings have been identified through the interviews and the data obtained during the research.

A. DTC GOAL-SETTING POLICY GUIDANCE

Present DoD policy directives for Design-to-Cost furnish little specific guidance for the goal-setting process or procedure. There is ample discussion of goal content and specification, goal documentation, and the necessity for "difficult but achievable" goals. A methodology or set of guidelines for establishing a future cost goal that will meet the difficult but achievable criteria was found to be lacking.

B. AVIONICS SUBSYSTEMS ACQUISITION

Many of the avionics subsystems of the major DTC tactical aircraft programs are being procured by the prime airframe contractors in a manner that has not significantly changed in recent years. Although DTC goals, cost tracking, and cost reporting have been introduced into the second tier subcontractor purchase orders, the basic ingredients of a DTC program--cost, schedule, and performance flexibility, including competition--were absent during full-scale development programs for most of the F-16, F-18, AAH, and A-10 avionics subsystems. The DTC goals for these subsystem programs were found to be the option prices negotiated for follow-on procurement contracts.

C. DTC AVIONICS ACQUISITION

The few cases where authentic DTC subsystem development programs were found were characterized by in-house funding or by prime contracts directly from Government procurement agencies for cost-type development programs containing inherent design and schedule flexibility. Goal-setting for these programs took a more disciplined course, with several participants and numerous goal-setting criteria being considered.

D. GOAL-SETTING CRITERIA

Criteria found for establishing DTC goals included the following:

(1) cost of existing equipment

(2) cost estimates of independent in-house and contractor organizations

(3) cost estimates from potential customers

(4) contractor proposals

(5) projected budget affordability

(6) OSD direction.

Criteria based upon potential contribution to major system missions (mission worth) were not explicitly found. Budget affordability also was inadequately supported to be a credible basis for goal selection.

E. LIFE-CYCLE COST GOALS

In every program examined, life-cycle cost estimates played an important role in choosing alternate performance levels, design approaches, maintenance philosophies, and, indirectly, the ultimate DTC goal for the production unit. In all the candidate cases, however, the life-cycle cost values were used for relative ranking of alternatives rather than discrete cost targets. Life-cycle cost goals were not established as specific targets to be pursued or measured.[1]

F. GOAL-SETTING PROCESSES

It was found that, in those cases where cost goals were consciously set by the Government program manager, the process was initiated early in development prior to the engineering development phase. Typically, the process drew guidance from several sources of information or criteria. In every instance, the involvement and estimating roles of current or potential equipment suppliers was important. Independent cost estimates, obtained from both outside contractors as well as in-house estimating activities, also played a major part in analyzing contractor estimates and supporting the cost goal selection. It was found that, once established, the cost goals did not change for the subsystems investigated.

G. GOAL-SETTING AND COMPETITION

The interviews and program analyses found that competition is frequently a factor in the goal-setting process as well as in the program outcome. It was found that goal-setting early in the concept formulation stage could be enhanced by competitive approaches to meeting the functional requirements at lowest projected costs. Competition can also help to assure that the costs goals selected are "difficult but achievable."

It was found that there is a great difference between goal-setting and competitive pricing. Goal-setting was found to be a structured analytical process using several of the

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[1]Reliability and maintainability often were used as surrogates for operations and maintenance cost targets because these performance parameters, together with unit production cost, usually were the principal variables in life-cycle cost calculations. The pricing and negotiation of reliability warranties or guarantees also introduced these key operational cost variables into the DTC programs as measurable contractual cost elements.

criteria observed to determine a "should cost" value for a future system or subsystem. This process of estimating involved assumptions about contractor efficiency, economic price movements, profit level, technological advances, production learning rates, and future production rates and quantities. Competitive pricing practices were found to yield different values for unit production costs; the cases examined demonstrated competitive prices approximately 25 percent lower than pre-set cost goals. Competitive pricing was found to be the basis for the subcontractor cost goals when performing as a second tier contractor to major system prime contractors.

Since the assumptions and criteria for contractor pricing can be quite different than those for cost goal establishment, the distinction between the two sources of cost goals was found to be important in understanding the goal-setting process.

H. GOAL ESTIMATING METHODOLOGY

The limited research effort did not identify the specific cost goal estimating methodology used for the candidate systems. While this information was sought, records, reports, or other analytical documentation containing this data was not found. Additionally, there was no evidence uncovered by the research that probabilistic decision processes were used to set a "difficult but achievable" cost goal.

VI

CONCLUSIONS

Based upon the research findings, conclusions can be supported in areas of goal-setting policy, goal-setting processes, and competition.

A. GOAL-SETTING POLICY

Because of the lack of specific goal-setting policy guidelines or suggested methodologies, it is concluded that service program managers must develop and tailor goal setting plans of their own. This approach can result in inconsistent application of decision criteria for similar systems and goals which are not, "difficult but achievable."

B. GOAL-SETTING PROCESSES

Where cost goals have been set as a conscious activity prior to engineering development, they have properly included input from many sources and have considered appropriate criteria for threshold values. The exclusion of "mission worth" did not appear to be important at the subsystem level and probably would not have influenced the goal-setting process providing that the essential performance parameters were not affected.

C. COMPETITION

Competition results in price levels that may bear no relationship or have any basis common to the criteria and processes used to establish DTC goals. Since a common procurement problem area in the past was belief that competitive bid prices could be achieved without serious program difficulties or cost overruns, it appears to be presumptuous to translate competitive prices into DTC goals without other DTC program prerequisites. This is especially true whenever the basic ingredients of DTC policy are removed through the process of a fixed-price, schedule-constrained subcontracts for full-scale development with priced options for production. When design cost goals exist, it appears unwise to substitute competitive prices for the cost goals during production program negotiation unless it can be demonstrated that basic assumptions supporting the original cost goal have become invalid.

D. COST GOAL CREDIBILITY

Based upon findings in areas of candidate program outcome and estimating methodology, there remain doubts that the cost goals set for most of the programs were challenging to the contractors. If the goals were, in fact, difficult but achieveable, it then must be concluded that product pricing decisions, which result in prices lower than cost goals, are more dominant in the acquisition process than cost goal achievement or DTC development discipline.

VII

GUIDELINES FOR GOAL-SETTING POLICY

A. COST GOAL PERSPECTIVE

In order to improve the cost goal-setting process, several elements of past program experience need to be given more emphasis. The process should be recognized as the key first step toward achieving cost discipline in the acquisition of systems and subsystems. A documented plan for cost goal establishment should be prepared by the program manager. This plan should consider:

1. Mission worth and affordability.
2. Costs of alternate or existing systems.
3. The cost impact of new technology in product design and manufacturing process.
4. Independent cost estimates.
5. Potential market for the system.
6. Competitive environment.
7. Life-cycle cost sensitivities.
8. Ranges of likely cost values, (depending upon the various assumptions).
9. The selection of a cost goal which is challenging enough that there is a definite probability that it may not be achieved.

B. COST GOAL MANAGEMENT

For major weapon systems, there are provisions for adjustment of design-to-cost goals at key milestones in the acquisition process. This formal flexibility should be extended to less-than-major programs. In addition, each major milestone of the program should include a reassessment of the cost goal based upon the knowledge gained thus far during the program. With proper documentation, substantiation, and authorization, the cost goal should be able to be re-established at either higher or lower levels within the range of affordable costs.

C. COST GOAL CREDIBILITY

Cost goal credibility can be enhanced through careful goal establishment and periodic review as recommended above. If these measures are pursued, then the practice of awarding contracts based upon the outcome of competitive pricing or "best and final" offerings should be reevaluated. The source selection criteria should be based upon maximum equipment performance attainable at a "difficult but achieveable" cost goal, life-cycle cost implications, and confidence in the contractor's design, manufacturing capability, management, and past contract performance.

APPENDIX A

IDA TASK ORDER T-140

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
1400 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22209

TASK ORDER FOR WORK TO BE PERFORMED
BY
INSTITUTE FOR DEFENSE ANALYSES

TASK ORDER T-140 DATE: 1 December 1976

You are hereby requested to undertake the following task:

1. TITLE: Design-to-Cost Goal Setting

2. INTRODUCTION: Most major weapon systems and many subsystems entering the post-DSARC II or engineering development stage have unit production cost goals. In addition, life-cycle cost goals have been requested by OSD for many systems having significant portions of their costs generated during the operational phase. The purpose of these goals is to provide additional system and subsystem design requirements early in the development process such that cost growth is arrested and field performance in terms of reliability and maintainability is achieved.

Previous investigations of the design-to-cost process have indicated that the cost goals established for these programs are derived in a variety of ways; goals were selected based upon the cost of the previous equipment, what informed sources thought that it "should cost," perceived budget affordability, arbitrary assignment, and competing contractor estimates. The alternative of estimating the worth of an equipment's mission or the cost of alternative ways to perform a given mission was seldom, if ever, investigated as a technique for cost goal establishment.

The proper selection of unit production or life-cycle cost goals is critically important and affects not only the ultimate force capability, but also the performance and reliability which are inherent ingredients in the basic design.

Greater understanding is needed of the considerations which should enter into goal setting, the optimum timing, the assignment of responsibilities, and current methodology available to the OSD and the Services.

3. OBJECTIVE: The objective of this task is to investigate the process of production and life-cycle cost goal setting. Primary emphasis will be directed to identifying guidelines and methodologies for goal establishment in early development.

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4. SCOPE: The scope of this task will be limited to a consideration of goal establishment experience and candidate methodologies applicable to aircraft avionics associated with either the air-to-air or air-to-ground tactical missions.

5. SPECIFIC TASKS:

1. Investigate newly-developed Air Force, Army, and Navy tactical aircraft and derive a list of candidate mission avionics having design cost goals suitable for analysis.

2. For each avionics candidate, determine, within the constraints of time and data availability, the history and related facts concerning the equipment cost target or goal, including the identification of methodology, alternatives considered, principants, and decision criteria.

3. Based upon the data acquired and experiences of the Services, formulate guidelines for future goal establishment, and propose candidate methodologies to be considered for cost goal quantification.

6. SCHEDULE: A draft report will be completed and delivered within eight months from initiation of this study. Interim progress briefings will be held at 90 day intervals during the study.

7. TECHNICAL COGNIZANCE: Deputy Director (Policy and Planning), ODDR&E.

8. SCALE OF EFFORT: This task shall be at a level of effort equivalent to six man months. A maximum of $55,000, expended during an eight month interval, is authorized for this task.

9. REPORT DISTRIBUTION AND CONTROL: The Deputy Director, (Policy and Planning), ODDR&E, will determine the number of copies of reports and their distribution. A "need-to-know" is hereby established in connection with this task and access to U.S. and foreign program information in the field of this task is authorized for participating personnel as deemed necessary.

Department of Defense support, such as access to classified documents and publications, security clearances and the like, necessary to complete this task will be obtained through the Director, ARPA.

George H. Heilmeier

ACCEPTED: Alexander H. Flax
President, IDA

DATE: 29 November 1976

APPENDIX B

EXCERPT FROM GENERAL DYNAMICS REQUEST FOR PROPOSAL 74-12; SUBCONTRACTOR PERFORMANCE MEASUREMENT REQUIREMENTS FOR DESIGN-TO-COST

SUBCONTRACTOR PERFORMANCE MEASUREMENT

DESIGN TO COST

GENERAL DYNAMICS
Fort Worth Division

MANPOWER REPORT

1. The report will be prepared for the following categories of manpower:

   a. Engineering

   b. Tooling

   c. Manufacturing

   d. Other Direct

   e. Total Direct

   f. Indirect

   g. Total

2. For each of the above categories of personnel, forecast and actual manpower data will be developed by contract. Equivalent manpower will be used.

SUBCONTRACT PERFORMANCE MEASUREMENT
DESIGN TO COST

INDEX

SUBCONTRACTOR PERFORMANCE MEASUREMENT

DESIGN TO COST

Purpose

1.0 This document establishes the minimum requirements which the seller's internal cost, schedule and technical performance management process must meet to satisfy General Dynamics Design to Cost requirements.

Objective

2.0 To provide assurance that seller's internal cost, schedule and Technical performance management process is sufficient and effective for planning and controlling the tasks specified sufficiently in order to meet or better the Design to Cost goal established for Production and the cost negotiated for Full Scale Development.

2.1 The primary objective during Full Scale Development is to design to a cumulative average unit production cost of <u>to be proposed by seller</u> expressed in FY 1975 dollars for a total of 1,000 systems, to attain a maximum production rate of 15 systems per month.

2.2 Implementation of this criteria is considered to be good management practice. Application of this requirement is not intended to require the use of a specific management system or require the seller to change or reorganize in any specific way. The objective is to utilize the seller's management system as much as possible.

2.3 The seller is expected to include as a management objective during Full Scale Development the control of downstream operating and support costs. General Dynamics will entertain seller requests for adjusting the design to cost goal at any time during the period of this contract for real or demonstratable cost of ownership savings which would result in an overall life Cycle cost benefit. The seller's proposal for adjusting the average unit production cost goal must be supported by sufficient justification and data which would substantiate a high degree of confidence that the Life Cycle cost savings will be realized.

Policy

3.0 Guideline DOD Policy - DOD Directive 5000.1 Design to Cost "Cost Parameters shall be established which consider the cost of acquisition and ownership, discrete cost elements (e.g. unit production costs, operating and support costs) shall be translated into "design to" requirements. System development shall be continually evaluated against these requirements with the same rigor as that applied to technical requirements. Practical trade-offs shall be made between system capability, cost and schedule. Traceability of estimates and costing factors, including those for economic escalation, shall be maintained."

Definition

4.0 Unit production costs are defined as the sum of all recurring and non-recurring costs (excluding all RDT&E costs) necessary to produce a complete system.

Work Breakdown Structure

5.0 The Work Breakdown Structure will serve as the framework for tracking under design-to-cost. The seller is expected to break down his cumulative average unit production cost goal into unit production cost goals for major components of the system. The seller then identifies lower levels of hardware elements which are assigned to engineering managers or design groups. The unit production cost goal will be allocated to these elements as part of the design requirements. Normally it will be at this level that the seller manages the development of the system and tracks and controls the achievement of the design to cost goals.

5.1 Work Breakdown Structure established for FSD will also be used to separately report the Production Program. This Work Breakdown Structure must be the same as the Cost Schedule Control System (CSCSC) WBS used in the Proposal.

5.2 The work breakdown structure must depict the structure of all effort to fulfill the program statement of work requirements and must be used to allocate all resources to be utilized in fulfilling this requirement. Refer to Attachments (A) and (B).

5.3 The work breakdown structure must be oriented to permit performance measurement for all work breakdown structure elements and for all organizational elements to the lowest task breakdown level. This will include software as well as hardware.

5.4 General Dynamics will review the Production and FSD Work Breakdown Structures and concur to the total Work Breakdown effort.

Tracking

6.0 Tracking provides a means for ascertaining whether the design of the product is such that it can be produced within the pre-established unit production cost goal, and if not to give a warning of this in time to permit corrective action. It also provides the means for maintaining a historical record of what has transpired.

6.6 The estimated production goals of the designs for the hardware elements will be generated and fed back to the responsible design managers as the system is developed. Comparison of these estimates with the goals will identify the unit production cost status of the design of the various hardware elements at the 3rd level. Summarization of those estimates through the higher level WBS will allow the tracking of the unit production cost status at the 2nd level work breakdown structure. Summarization from this level will allow the seller to relate the current estimated unit production cost to the 1st level or Unit Production cost goal for the system.

Reporting

7.0 The Production Program and the Full Scale Development Program must both be reported. Each Program must be reported separately.

7.1 All reporting shall be displayed in FY 75 dollars and then year dollars.

7.2 The seller's proposal estimates identifying the design to cost cumulative average unit production cost goal shall service the cost baseline against which deviations shall be reported. Any change over $1,000 to the seller's original concepts, design and or assumptions which will change the seller's unit production cost goal shall be reported in Part 5, Problem Analysis, of the Monthly Cost Performance Report (CPR) showing the effect in FY 75 dollars and then year dollars.

7.3 The seller's proposal as negotiated for the Full Scale Development Program shall serve as the baseline against which deviations shall be reported. Any change over $1,000 to the seller's original concepts, 6.1 The seller shall control and track his design to a cumulative average unit production cost target throughout the development cycle compatable with the work breakdown structure.

6.2 Tracking will include both the Full Scale Development Program and the Production Program. Each Program must be separately controlled and reported.

6.3 Seller must track (compute, project, or measure) the expected performance of their system design and the associated hardware elements. This is necessary to provide the information needed to identify potential trade-offs between desired performance and cost.

6.4 The seller shall use his existing cost control system to identify the area of change from the original development plan and serve as a tracking vehicle to ascertain effects of a development change and any other change to the unit production cost.

6.5 Tracking of status against a Design to Cost goal involves generating a series of estimates of the systems unit production cost. The baseline estimate should be updated whenever significant new system design or estimating data becomes available. "New" design data is considered to be a design change or the development of the design data in sufficiently greater detail e.g., breakdown from the assembly level to the individual parts. Changes in estimating data includes both changes in cost data and changes to the assumptions on which the estimate is based. (Examples of such changes include changes in production delivery schedules and quantities, inflation rates, manufacturing plans and labor and overhead rate projections).

Report Discription	Full Scale Development Program	Production Program	Frequency
Attachment			
(A) Work Breakdown Structure - TASK BASELINE -	X	X	30 Days after go-ahead
(B) Work Breakdown Structure - TASK CHANGE -	X	X	30 Days after receipt of contract change authorization
(C) Hardware Element Report - 3RD LEVEL WBS -	X	X	Monthly
(D) Unit Cost Report - 2ND LEVEL WBS -	X	X	Monthly
(E) Program Report - 1ST LEVEL WBS -	X	X	Monthly
(F) Cost Performance Report - Problem Analysis, Part 5 only	X	X	Monthly + as it occurs
(G) Trade Studies		X	As required

design and or assumptions which will change the seller's proposal as negotiated shall be reported in Part 5, Problem Analysis, of the Monthly Cost Performance Report (CPR) showing the effect in FY 75 dollars and then year dollars.

7.4 Reporting in Part 5, Problem Analysis of the CPR shall include analysis of the impact of changes (configuration changes, new design data, changes to assumptions, schedule changes etc) on the seller's unit production cost goal and Negotiated Proposal for Full Scale Development for each affected Work Breakdown Structure Element.

7.5 The seller will report actions (including any trade offs) he proposes to take to bring the cost within the limit of the established unit production cost goal.

7.6 Reporting will be on a monthly basis for all required reports. The Part 5, Problem Analysis of the CPR will also be reported during the month as soon as the problem has been isolated.

7.7 A formal review of cost status on the cumulative average unit cost goal will be held based on each of the following milestones in the Full Scale Development Program.

(1) Preliminary Design Review

(2) Critical Design Review

(3) 1st Hardware Delivery

7.8 The seller shall submit the reports listed below:

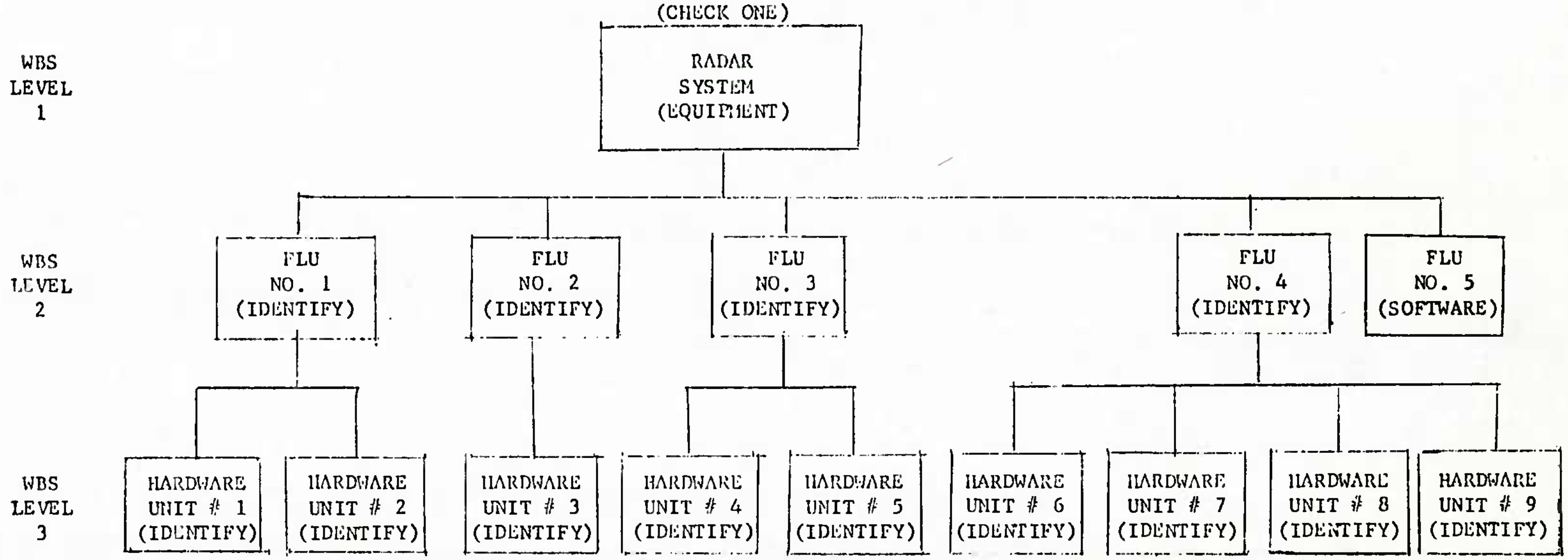
Report Discription	Full Scale Development Program	Production Program	Frequency
Attachment			
(A) Work Breakdown Structure - TASK BASELINE -	X	X	30 Days after go-ahead
(B) Work Breakdown Structure - TASK CHANGE -	X	X	30 Days after receipt of contract change authorization
(C) Hardware Element Report - 3RD LEVEL WBS -	X	X	Monthly
(D) Unit Cost Report - 2ND LEVEL WBS -	X	X	Monthly
(E) Program Report - 1ST LEVEL WBS -	X	X	Monthly
(F) Cost Performance Report - Problem Analysis, Part 5 only	X	X	Monthly + as it occurs
(G) Trade Studies		X	As required

ATTACHMENT (A)

DESIGN TO CO
WORK BREAKDOWN STRUCTURE
- TASK BASELINE -

FULL SCALE DEVELOPMENT
OR
PRODUCTION

(CHECK ONE)

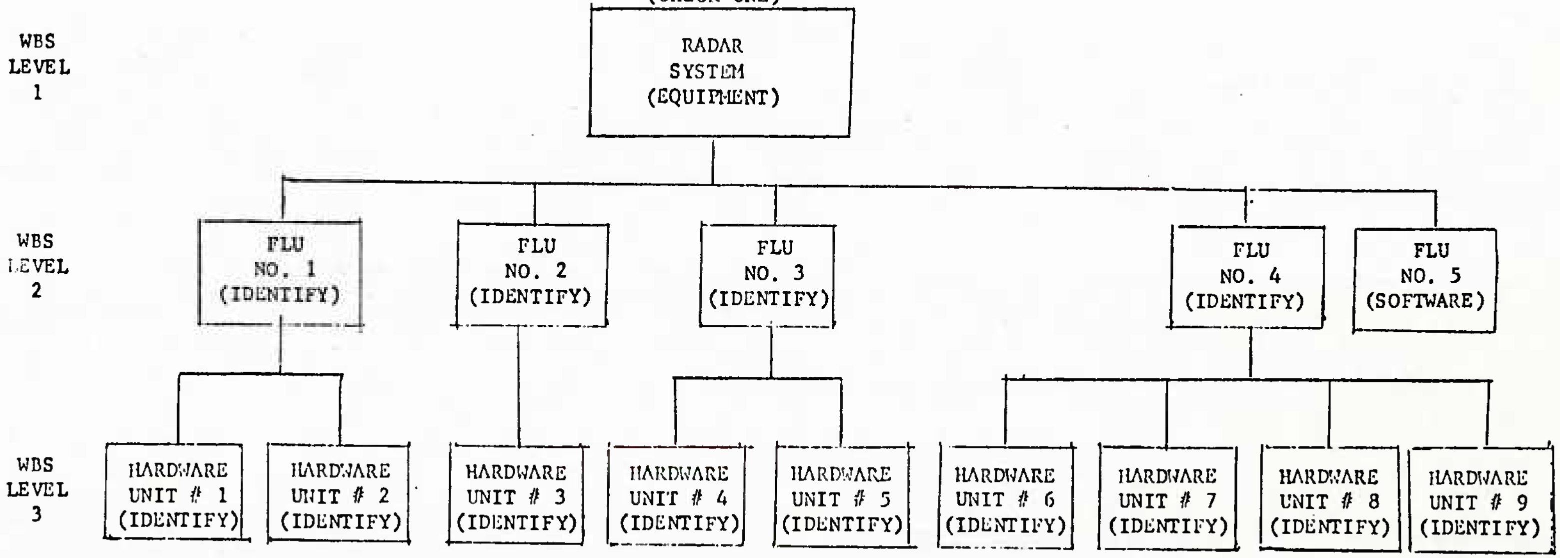


ATTACHMENT (B)

DESIGN TO COST
WORK BREAKDOWN STRUCTURE
- TASK CHANGE -

FULL SCALE DEVELOPMENT
OR
PRODUCTION

(CHECK ONE)



DESIGN TO COST
HARDWARE ELEMENT REPORT

FULL SCALE DEVELOPMENT ☐
OR
PRODUCTION ☐

(CHECK ONE)

ELEMENT	WORK BREAKDOWN STRUCTURE NO.	UNIT COST GOAL	CURRENT VARIANCE
Identification	(3rd Level)	XXX	XXX

Comments:

____

____

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____

____

Engineering ____________________

ATTACHMENT (D)

DESIGN TO COST
UNIT COST SUPPORT

FULL SCALE DEVELOPMENT ☐
OR
PRODUCTION ☐

(CHECK ONE)

Element	Work Breakdown Structure No.	Current Estimate or	Variance	Cross Reference
(End Item Description)	(2nd Level)	(Actual)		(To Problem Analysis Report No.) Attachment (F)
1.				
2.				
3.				
4.				
Etc.				

Total Unit Cost

FLU No. ________

DESIGN TO COST
- TRADE STUDIES -

- THIS IS AN AS REQUIREMENT THAT WILL BE INITIATED BY THE SELLER DUE TO THE PROCESS OF TRACKING EXPENDITURES ON HIGH COST SYSTEM ELEMENTS WHEN AND IF ONE OR MORE OF THESE ELEMENTS APPEARS TO BREACH COST GOALS.

- THIS SHOULD BE A NARRATIVE REPORT THAT WILL BE IN SUFFICIENT DEPTH FOR GENERAL DYNAMICS TO EVALUATE FULLY IMPACTS, SUCH AS PERFORMANCE, DEGREE OF ATTAINMENT OF CONTRACT REQUIREMENTS, RELIABILITY - MAINTAINABILITY - SAFETY, MANUFACTURING, MATERIALS AND REDUCTIONS IN DESIGN TO COST AND LIFE CYCLE COST.

- THE SELLERS REPORT WILL INCLUDE THE DATA RESULTING FROM CONDUCTING AN IMPACT ANALYSIS WHICH WILL INCLUDE:

  - DEFINING THE DETAIL OF THE POTENTIAL CHANGE
  - IMPACTS (BENEFITS/PENALTIES) ON PERFORMANCE, REQUIREMENTS, RELIABILITY/MAINTAINABILITY, SCHEDULE AND RISK.
  - IDENTIFICATION OF TASK CHANGE TO THE LOWEST LEVEL WBS ELEMENT INVOLVED.

CLASSIFICATION

Page ___ of ___

CONTRACTOR: LOCATION: RDT&E ☐ PRODUCTION ☐	COST PERFORMANCE REPORT – PROBLEM ANALYSIS			FORM APPROVED OMB NUMBER 22R0280
	CONTRACT TYPE/NO.:	PROGRAM NAME/NUMBER:	REPORT PERIOD:	

EVALUATION

Section 1 - Total Contract: Provide a summary analysis, identifying significant problems affecting performance. Indicate corrective actions required, including Government action where applicable.

Section 2 - Cost and Schedule Variances: Explain all variances which exceed specified variance thresholds. Explanations of variances must clearly identify the nature of the problem, the reasons for cost or schedule variance, impact on the immediate task, impact on the total program, and the corrective action taken. Cost variances should identify amounts attributable to rate changes separately from amounts applicable to manhours.

Within this section, the following specific variances must be explained:

a. Schedule variances (Budgeted Cost for Work Scheduled vs Budgeted Cost for Work Performed)
b. Cost variances (Budgeted Cost for Work Performed vs. Actual Cost for Work Performed)
c. Cost variance at completion (Budgeted at Completion vs. Latest Revised Estimate at Completion)

In addition to the variance explanations above, the following analyses are mandatory:

a. Identify the effort to which the undistributed budget applies
b. Identify the amount of management reserve applied during the reporting period, the WBS elements to which applied, and the reasons for application

Section 3 - Baseline: If the difference shown in block (7) on format 3 becomes a negative value or changes in value, provide:

a. Procuring activity authorization for the baseline change which resulted in negative value
b. The amount (by WBS element) used to adjust for unfavorable performance incurred prior to the baseline change
c. The amount (by WBS element) added to budgets previously established for future effort. Explain reasons for the additional budget in the following terms:
   (1) In-scope engineering changes
   (2) In-scope support effort changes
   (3) In-scope schedule changes
   (4) Economic change
   (5) Estimating change
   (6) Unpredictable change
   (7) Other (specify)
d. The amount (by WBS element) for added in-scope effort not previously identified or budgeted

Format 5

DESIGN TO COST
PROGRAM REPORT

Program ______________________________

Contractor ______________________________ Date ________________

Purchase
Order No. ______________ System ______________________ Work Breakdown
Structure No. ________________________

Production			Full Scale Development		
Unit Prod Cost Goal	Estimate	Variance	Unit Cost Goal	Current Actual	Variance
XXX	XXX	XXX	XXX	XXX	XXX

Comments:

____ ____

____ ____

____ ____

____ ____

Program Director/Manager ________________________
Signature