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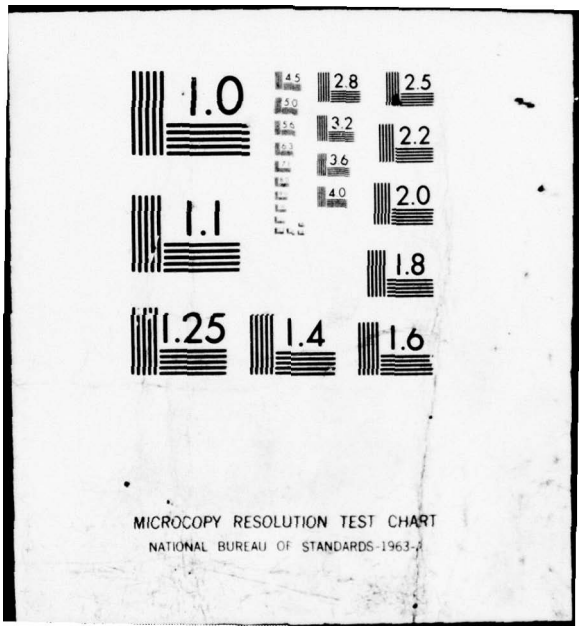
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REQUIREMENT: COST EFFECTIVE DEVELOPMENT OF NEW ARMY AVIATION SYSTEMS

PMC 73-1

Ronald K. Andreson
LTC USA

REQUIREMENT: COST EFFECTIVE DEVELOPMENT OF NEW ARMY AVIATION SYSTEMS

An Executive Summary
of a
Study Report
by

Ronald K. Andreson
LTC USA

Defense Systems Management School
Program Management Course
Class 73-1
Fort Belvoir, Virginia 22060

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DEFENSE SYSTEMS MANAGEMENT SCHOOL

STUDY TITLE: REQUIREMENT: COST EFFECTIVE DEVELOPMENT OF NEW ARMY AVIATION SYSTEMS

STUDY PROBLEM/QUESTION: To investigate recent techniques that have been undertaken to improve the Army RDT&E cycle in technical quality and cost reduction utilizing the Cheyenne/Advanced Attack Helicopter (AAH) and the Heavy Lift Helicopter (HLH) programs as case examples for application of revised material acquisition procedures.

STUDY REPORT ABSTRACT:
The paper investigates techniques that have been taken to improve the Army RDT&E cycle through study of refinements to the requirements documentation process, selection of Project Manager criteria, and evaluation of the Cheyenne/Advanced Attack Helicopter and Heavy Lift Helicopter programs. The conclusions are that improvements have been implemented that will provide for more cost-effective development and acquisition of new weapons systems for the Army in today's environment of austere defense funding.

KEY WORDS: WEAPON SYSTEMS, AIRCRAFT, HEAVY LIFT AIRCRAFT, DESIGN-TO-COST, HELICOPTERS, cheyenne

Student, Rank Service	Class	Date
Ronald K. Andreson, LTC U.S. Army	PMC 73-1	May 1973

EXECUTIVE SUMMARY

Within the past four years developmental difficulties on major systems acquisition programs have focused national attention on the management techniques utilized by the armed services in the procurement of new materiel. Cost overruns and cost growth experienced on large military procurements have been given wide publicity. The Defense dollars of tomorrow will be severely limited, and the criticism of wasteful practices on military procurement programs dictates that the Army seek every available means of reducing the costs associated with weapons systems acquisition while insuring that the requisite operational capability is maintained.

Improvements have been initiated and implemented throughout the Army's materiel development community to alleviate discrepancies that occurred on previous procurement programs. A more flexible approach to weapons system definition has been adopted in the Materiel Need/Required Operational Capability documentation which replaces the more rigid Qualitative Materiel Requirement methodology. Revised criteria for the selection of Project Managers and stabilization of their duty tours has considerably strengthened the decisionmaking process and provided continuity of management on major acquisition programs.

Two Army programs for development of aviation systems offer excellent case examples of past deficiencies and the innovative techniques that have been applied to improve the acquisition process. These are the Cheyenne/Advanced Attack Helicopter and the Heavy Lift Helicopter.

The Cheyenne helicopter development, contracted under the "total package procurement" concept, was cancelled in 1972 and a follow-on acquisition program was initiated for a more austere lower risk/lower cost system entitled the Advanced Attack Helicopter.

Total program costs for the Cheyenne far exceeded those originally envisioned, and coupled with technical difficulties in the development, forced eventual termination of the program. The follow-on effort for the Advanced Attack Helicopter has been initiated under the guidelines of DODI 5000.1 and the "design to cost" strategy. The development will feature competitive prototyping and full assessment of all cost and technical risks prior to a favorable production decision.

The Heavy Lift Helicopter program was initiated during the turbulent transitional period when cost overruns and technical deficiencies on military acquisition programs were making daily headlines. As a result, program format coincides with the more austere "fly before buy" philosophy initiated by Deputy Defense Secretary Packard in 1969. The development was originally approved as an Advanced Technology Program to design, fabricate and preliminary test critical HLH components in order to verify technical feasibility and performance acceptability prior to system development. Success in the component program has resulted in recent approval of a prototype development which will test the technology gains achieved thus far without premature massive commitment of funds to a full scale effort. If the present record of successful progress is maintained, production of limited quantities of the HLH is anticipated for the 1976-1980 time frame.

REQUIREMENT: COST EFFECTIVE DEVELOPMENT OF NEW ARMY AVIATION SYSTEMS

STUDY REPORT

Presented to the Faculty
of the
Defense Systems Management School
in Partial Fulfillment of the
Program Management Course
Class 73-1

by

Ronald K. Andreson
LTC USA

May 1973

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ABSTAINER

This study represents the views, conclusions and recommendations of the author and does not necessarily reflect the official opinion of the Defense Systems Management School nor the Department of Defense.

CHAPTER I

INTRODUCTION

> The ultimate objective of Army research and development is to develop for the Department of the Army weapons systems and equipment capable of being effectively manned and superior to those of any potential enemy in any environment and under all conditions of war. (27:1-1)

The above definition cited in Army Regulation 705-5 in 1968 was an entirely valid statement of the Army's research and development objectives until recent difficulties across a broad spectrum of developmental programs brought into sharp focus the realism that it is not possible in today's national environment to provide U.S. Armed Forces with an unending array of sophisticated weaponry regardless of cost. The Research Analysis Corporation (RAC) concluded in a study conducted under Army contract that a more meaningful objective is to maximize the function of increased mission capability with the costs incurred in obtaining a new item of military hardware. (19:8) Thus, RAC obviously incorporates the realistic element of the budget into the definition, underscoring a major problem facing all military managers in today's era of austere funding and constrained budgets. Today's "ultimate objective" is to achieve a significant measure of new weapons system performance at minimal dollar cost.

> The pressure on the Department of Defense to reduce expenditures is strong.... We see new pressures on Defense to maintain the current worldwide posture in a time of rapidly expanding technological capability without creating significant new demands on financial resources.... Living within a projected level budget in FY 73 dollars means weapons must be designed at a cost

> we can afford so we can own a sufficient number to maintain a modern force of adequate size to protect our national interests. (20:1)

The above statement issued by former Deputy Secretary of Defense Rush in 1972 focuses on the pressure for allocation of the nation's limited financial wealth to solve social and environmental problems and simultaneous closer scrutiny and criticism by cognizant Congressional committees and the news media on the size and disposition of the Defense dollar. Cost overruns and cost growth experienced on large military procurements such as the C-5, the Cheyenne helicopter, and more recently the F-14 have been given wide publicity. Whereas "performance at almost any cost" was an unwritten by-law during the heyday of the Vietnam conflict, the term "design to cost" (and in fact, minimal cost) is now an overriding consideration. The Defense dollars of tomorrow will be severely limited, and the criticism of wasteful practices on military procurement programs dictates that the Army seek every available means of reducing the costs associated with weapons systems acquisition while insuring that the requisite military capability is maintained. The problem facing today's acquisition manager is particularly perplexing since the diminishing size of the armed forces and lower equipment densities require increased emphasis on the technological superiority of combat materiel in order to realize the cited objective of defeating all potential enemies.

This study paper will concisely examine discrepancies of past procedures and changes that have occurred in the Army's process for materiel requirements formulation and management of systems acquisitions programs during the transitional period of the past four years. The Cheyenne program will be discussed with regard to past discrepancies and changes that have been implemented under the revised Advanced Attack Helicopter procurement to improve the development cycle of this most important weapon system in the Army force structure. The Heavy Lift

Helicopter program will be analyzed for the impact of OSD's present "low risk/fly before buy" policy on program format. Although the thrust of this paper is oriented toward the development of high-cost complex systems, the management techniques discussed apply equally to smaller, less complex Army programs.

CHAPTER II

IMPROVING THE ACQUISITION PROCESS

General

The responsibility for formulating Army hardware requirements, relating these requirements to development of new weapons systems, and then procuring the developed materiel is divided between two major field agencies. These are the U.S. Army Combat Developments Command (CDC) and the U.S. Army Materiel Command (AMC). (27:1-5)

The CDC function of primary significance to weapons system acquisition is to determine how the Army of the future will be equipped. (27:1-6) To accomplish this function CDC must provide a definitive answer to the question "What is required?" to respond to the threat or deficiency. Until 1970 this was done through initiation of a materiel requirements document entitled a Qualitative Materiel Development Objective (QMDO) or a Qualitative Materiel Requirement (QMR). Today the QMDO-QMR system has evolved into a more streamlined and abbreviated documentation process called the Required Operational Capability (ROC). All of these documents are statements of the description and need for new items of equipment for future utilization by U.S. Army forces in the field.

Subsequent to requirement definition and Department of the Army approval, it becomes the responsibility of AMC to initiate and manage the technical development programs necessary for translation of the written document into operational hardware. (27:1-6) For major systems as defined in DODDI 5000.1 this is accomplished under the auspices of a single manager, the Project Manager (PM), who is appointed by the Secretary of the Army. Management of low-cost lower priority programs that do not meet 5000.1 thresholds is generally assigned to a product manager or to a functional element

within one of AMC's major commodity commands.

Army Project Management

The Army, as well as the other services and industry, has recognized for some years the critical importance of intensive management for major weapons systems acquisition programs. Project management was initiated by the Army on a large scale in 1962 when nine high priority development programs were assigned to Project Managers. (9:27) The action was precipitated by the difficulty in providing horizontal coordination between the functionally oriented AMC commodity commands, the CDC, and industry. PM's were authorized to cut across functional lines within AMC and deal directly with other commodity commands, the "user" as represented by CDC, and with industrial contractors. The expansion of the number of project managed programs since 1962 indicates the general success the concept has experienced in effecting adequate coordination and management. Presently, there are 40 chartered PM programs within the Army.

In a sense the Army Project Manager serves as both a commander and a staff officer. Within the limits imposed by his charter, he speaks and acts as the commander primarily responsible for the specified system development program. (23:4) He controls sizable resources allocated to his project and is normally assigned a vertically oriented organizational structure to assist in the technical and management functions dictated by the charter. With several exceptions, Project Managers are co-located with the commanders of the AMC commodity commands who have primary support responsibility for the system under development. (23:11) For example, all Project Managers for Army aviation system acquisition programs have their offices co-located with the Army Aviation Systems Command (AVSCOM) in St. Louis, Missouri. The Project Managers concerned report to the Commanding General, AMC, but are required to closely coordinate

of the program. On several occasions Project Manager reassignment was based on the individual's selection for attendance to a senior service school or other "career enhancing" duty position. Career development needs were assigned priority over sustained management of the program. Unfortunately, these reassignments often coincided or occurred prior to critical management milestones of the programs, with inevitable serious disruption of program continuity. Department of the Army's new criteria permits future reassignment of key personnel only after completion of critical milestones, for example, subsequent to the DSARC decision to proceed from Full Scale Development into Production. Since initiation of these revised procedures the decisionmaking process and program continuity have stabilized considerably. (24:Notes)

Refinement of Requirements Documentation

Achievement of flexibility is necessary in order to conduct system trade-offs during the development cycle. The importance of applying intelligent technical, cost and schdule trade-offs has been stated repeatedly in recent OSD guidance documents pertaining to the acquisition of defense weapons systems. Many of the Army's former development programs experienced serious cost overruns and schedule delays because the inflexible and firm requirements described in QMDO's and QMR's were established before the system could be adequately defined in design engineering or verified through prototype evaluation. Requirements documents contained very detailed and rigid documentation which left few options available to either the Project Manager or the contractor for performance trade-offs that could save time and money during the development process. Consequently, contractors were constantly reporting technical shortfalls where the QMR specifications could not be met without considerable cost increase or schedule slippage. Deviations could be waived only through a formal review process

requiring participation by numerous Government agencies and approval by the Department of the Army or DOD. The review process in itself caused considerable slippage in program continuation and usually generated stand-by costs charged to the Government by the development contractor. Inevitably, the resultant cost and schedule overruns on major programs became a focal point for scrutiny and criticism by Congress, and resulted in lesser quantities of new systems at higher unit cost to the Army. (9: 3-4)

On 31 July 1969, Deputy Secretary Packard issued a memorandum dictating the need for improving the requirements formulation process. (27:1-5) To meet the objectives of this policy statement a joint CDC/AMC board was established. The efforts of the board resulted in rejection of the QMDO/QMR documentation as too inflexible and unwieldy, and initiation of a Materiel Need (MN) Concept as the means to eliminate most of the deficiencies of the QMR/QMDO system of requirements formulation. The MN provided development objectives in the form of bands of performance which could be updated as the program progressed from Validation through Full Scale Development into Production. (22:203) The stated performance goals were not single value requirements, but rather a bounded range of acceptable parameter values that narrowed as technical accomplishment was verified through prototype testing. For example, the cruise airspeed requirement for a new rotary-wing aircraft using the Materiel Need documentation was stated as the range "230 to 270 knots" during Validation, then further definitized to perhaps "240 to 250 knots" during Full Scale Development and a firm determination was made relevant to what was within the technical state-of-the-art. This was a substantial improvement over the singular value dictated by the QMR, e.g., "245 knots", at the outset of concept formulation. The Materiel Need documentation, authorizing performance trade-offs within a specified range, provided less susceptibility to cost overruns and schedule slippages, and lowered

all requirements with the respective commodity commanders.

Although the concept of Army project management has been generally successful since its inception, recent measures have been taken to improve the overall effectiveness of this management technique. The actions focus primarily on the criteria used for selection of PM's and stabilization of key personnel within the program office.

Prior to 1971, criteria for selection of a Project Manager stated that the selectee possess a Bachelor of Science degree, be a graduate of the Command and General Staff College (or equivalent), and have demonstrated "performance potential" for promotion to "general officer". No specific rank was indicated as a firm requirement for major acquisition programs, and in fact, numerous officers in the grade of lieutenant colonel were assigned to lead Secretary of the Army chartered programs. Developmental difficulties occurred on numerous programs because of the PM's inexperience and relatively junior rank - the latter making it particularly difficult to effectively coordinate with other commodity commands and the Army Staff. In response to the guidance of Deputy Defense Secretary Packard's of 1969-1971, the Army upgraded its criteria for Project Manager selection to include possession of a Master of Science/Master of Arts degree, be a graduate of a senior service school (Army War College, ICAF, etc.), and be of military rank not lower than colonel (or lieutenant colonel-promotable). Presently, most major acquisition programs are managed by officers in the rank of brigadier general. (17:Notes) However, it should be noted that while the Army strongly supports schooling of key personnel at the DSMS, it does not require its newly chartered PM's to have any previous experience in systems acquisition management, or for that matter, any formal schooling prior to assumption of duty.

Although it will probably never be possible for key military personnel to remain with their programs for the entire development cycle which for some systems exceeds ten years, PM's and other key personnel were often reassigned with insufficient regard to the status

the requirement for numerous Government/contractor reviews.

A second major provision of the MN Concept centered on the principle of joint CDC/AMC effort throughout the development cycle. The QMR process had stipulated CDC management during requirements formulation and AMC management during hardware development. This split responsibility often resulted in AMC receipt of validated materiel requirements which were beyond their capability to meet within prescribed cost and schedule thresholds. All Materiel Need documents were prepared and staffed as a joint effort at the outset of planning and continuing through the entire development cycle. The principle of joint responsibility required a good working relationship across the CDC/AMC interface, particularly with the "working level" managers within the PM offices and their CDC counterparts. Two separate CDC/AMC joint groups were established - technical area specialists (engineering or performance oriented) and systems management specialists (cost and schedule oriented). In this manner it was possible for an appropriate system of checks and balances to be employed which helped the Project Manager insure that all considerations were accounted for during each incremental step of the development cycle. (24:Notes)

In August of 1972 the Army further refined its requirements documentation by replacing the Materiel Need format with the Required Operational Capability (ROC) - Development Plan (DP) Concept. (15:1-4) While retaining the essential and desirable characteristics of the MN documentation, the ROC/DP have streamlined administrative staffing through consolidation of voluminous documentation into two relatively concise volumes. The ROC replaces six Validation Phase MN documents, while the Development Plan is the single substitute for seven Full Scale Development Phase plans used in the MN concept. This latest refinement of systems acquisition documentation should serve to reduce staffing and decisionmaking lag time horizontally across the developer-user

interface and vertically up the hierarchial chain of command

Finally, it should be mentioned that the Army reorganization of 1973 will result in disestablishment of the Combat Developments Command and realignment of its functions under the newly formed Training and Doctrine Command (TRADOC) at Fort Monroe, Virginia. However, the approved restructuring is primarily a "headquarters change" and should not materially affect "user" responsibilities in the Army systems acquisition process.

CHAPTER III

CHEYENNE

Background

The Cheyenne (AH-56) compound helicopter was designed and developed to provide the U.S. Army with an accurate and lethal direct aerial fire support system effective in all potential worldwide hostile environments. At the time of program cancellation it was the most technically advanced, fully integrated rotary-wing weapon system in the world. Utilizing a rigid rotor system, the aircraft was capable of cruise airspeeds approximately 100% greater than the currently operational AH-1G Huey Cobra. It possessed the unique capability of maneuvering and engaging multiple targets simultaneously through the use of a computerized fire control system which incorporated laser range finding. The Cheyenne's armament included the TOW air-to-ground missile system and a high speed 30mm cannon. (20:1-2)

With all of these assets the AH-56 development program was formally terminated in 1972, and a follow-on acquisition program was initiated for a more austere lower risk/lower cost system entitled the Advanced Attack Helicopter (AAH). The Cheyenne was a victim of a combination of circumstances that provide a valid case example for verification of deficiencies in the former systems acquisition cycle. It should be noted that the Cheyenne met the objective standards for a weapons system cited in AR 705-5, i.e., it provided an aerial rotary-wing aircraft qualitatively superior to that of any potential enemy under all conditions of war. However the total program costs far exceeded those originally envisioned, and coupled with technical difficulties in the development, eventually forced termination of the program.

Cheyenne Program Difficulties

The Cheyenne was prime contracted with the Lockheed Aerospace Corporation under the Total Package Procurement Concept (TPP). (9: 25) This concept, initiated by former Secretary of Defense McNamara, required bidding contractors to enter into a fixed price "package" agreement for the cost of development, testing and production of a specified number of aircraft at the onset of the development cycle. In reality it required the contractor to accurately predict total costs and performance characteristics related with development and production years before all of the costs were incurred and the tests were conducted. It also required the contractor to accurately predict development milestones for time scheduling before the first item of test hardware had been produced. By 1972 the estimated unit cost of each aircraft had escalated to in excess of $4 million - more than double the original estimate. The program was also many months behind schedule. (24:Notes)

DOD reasoning on total package procurement in the early and mid-60's was that overall program costs for new weapons systems procurement could be reduced if a firm price could be established at the onset of development rather than in incremental units as successive milestones were passed. However, in the case of the Cheyenne, TPP generated huge cost overruns because Lockheed could not accurately predict the adverse effects of an inflationary wage spiral (dictated in part by the Vietnam conflict) and increased material costs. In their enthusiasm to win a big military contract, the company erroneously indicated that certain technical advances related to rigid rotor technology were within the state-of-the-art when in fact they were not. No limited scope test-bed program was required of the contractor to verify technical capabilities included in the QMR. It was not until the Cheyenne was far into its development cycle that technical deficiencies in the design of the system became apparent to the contractor and the

Government. Resolution of serious rotor instabilities caused numerous schedule extensions and the application of costly engineering fixes. For its part, the Army, in its urgency to obtain a new rotary wing aerial platform for rapid deployment to Vietnam, accepted cost and technical estimates with insufficient critical examination. (20: 5-7)

The original QMR for the AH-56 contained very detailed and rigid documentation which left few options available to either Lockheed or the Project Manager to save time and money during the development process. Single value requirements were established for cruise airspeed, dash airspeed, gross weight, endurance and numerous other performance parameters. (20:3) When ensueing aerodynamic instabilities limited the performance of the Cheyenne's main rotor and the engine did not quite develop the predicted power, there was no mechanism authorizing the conduct of technical trade-offs. That is, there was no capability to meet the more flexible bounded range performance requirements authorized under current DOD and Department of the Army guidance documents. Numerous special Government-contractor reviews generated additional time delays, themselves adding to cost overrun magnitude and placing the program in greater jeopardy of eventual cancellation.

A serious problem with management continuity developed in the Project Manager Office. Between 1965 (the year of initial chartering) and 1972, the program office served under the direction of five different Project Managers. Obviously the resultant managerial turbulence created an unfavorable impact on the program. Reassignment of several of the PM's was based upon career development considerations of the officer, i.e., the need to obtain credit for "combat time" in Vietnam or to attend senior service schooling. Program continuity was only a secondary consideration. Two of the early PM's were lieutenant colonels who had no previous experience in systems acquisition. One of these individuals was replaced when

it became obvious to the Army hierarchy that his inexperience and relatively junior rank made it extremely difficult for him to resolve the matrix of problems associated with the Cheyenne development. (22:4) It should be noted that the recently assigned Project Manager, in the rank of brigadier general, is experienced in RSD management and is expected to be stabilized with the current AAH program for an adequate period of time.

Restructured Advanced Attack Helicopter Program

The preceding discussion was critical of the AH-56 program, and it is relevant to point out that improvements have been initiated within the AAH program which will alleviate many of the encountered difficulties. The new development, initiated under the guidelines of DODI 5000.1, will be based upon reimbursable contracting with heavy incentivizing of costs during the Validation and Full Scale Development Phases. The entire program falls within the currently popular "design to cost" strategy for the acquisition of new weapons systems. The Request for Proposals, which was issued to industry in the late fall of 1972, enjoined all bidders to design the Advanced Attack Helicopter to a cost range of $1.4 million and $1.6 million flyaway cost per unit (bare aircraft as it leaves factory). A total life cycle cost ceiling of $3.2 million (constant FY 73 dollars) has been established for each aircraft. (15:14)

Performance characteristics for the AAH have been considerably reduced from those specified in the AH-56 program. The new system will have less endurance, speed, and navigation and automatic weapons accuracy. Rigid rotor technology will not be incorporated in the design since it still remains an area of inordinate technical risk. Bounded range performance requirements have replaced the single value requirements, permitting contractor and Government

trade-off of performance to coincide with cost and schedule objectives. The CPAF contract will contain specific provisions for Project Manager participation and control over the course and direction of the total program. (24:Notes)

The Source Selection Evaluation Board convened in St. Louis, Mo. in February 1973 to evaluate proposals from five prime contractors. Contractor response to the RFP were to include provisions for AAH commonality interfaces with the Utility Tactical Transport Aircraft System (UTTAS), another system acquisition program that has been approved for prototype development. Since the AAH is of the same relative size, utilization of common dynamic components (engine, transmission, drive shafts, etc.) should considerably reduce developmental risk and provide for better cost estimating. It is probable that one of the two winners on the UTTAS competition (Boeing or Sikorsky) would construct one of the fly-off prototypes since it will have developmental expertise with the dynamic components. However, the overall competition will be subdivided between the basic airframe and the mission sub-systems, i.e., navigation, fire control and weapons. Contractual provisions will allow matching the best airframe proposals with the most promising sub-system concepts during the fly-off competition. (15:14)

The systems engineering management plan for the AAH will establish Army "on site" engineering groups at contractor plants to function as the focal points for technical information and data exchange between the government and the contractor. The plan identifies organizational and interface relationships between the many Army technical agencies who have delegated responsibilities for the AAH program. It authorizes a standing committee chaired by the Project Manager's technical director and staffed with senior engineers from the various AMC commodity commands. The committee will meet as required to respond quickly on technical problems. The intended result is a systems engineering

organization capable of channeling the technical inputs of all elements more effectively than had occurred on the Cheyenne program and bringing them to bear on potential developmental difficulties with minimum duplication and lost time. (20:5)

If the developmental program is successful and maintains the planned schedule, the first production aircraft is expected to be fielded in mid-1978. Total planned production is in the range of 450-500 aircraft, stretching over a five year period. The AAH, like the predecessor Cheyenne, is the top priority acquisition program within the Department of the Army. It is critical to the Army that the improvements incorporated in the AAH development will result in a successful program leading to production of the world's most advanced rotary wing aircraft weapon system.

CHAPTER IV

HEAVY LIFT HELICOPTER

Background

Another major new Army aviation system on the development horizon is the Heavy Lift Helicopter (HLH). Army interest in an HLH dates back nearly twenty years to the mid-50's when studies indicated the feasibility of building a helicopter capable of lifting payloads ranging from 8 to 16 tons. Sikorsky Aircraft Division of United Aircraft Corporation built a 10-ton payload helicopter at this time, the CH-54, which the Army subsequently procured in limited quantities and deployed quite successfully in Vietnam. (10:1-4)

In 1963-64, the Army Aviation Materiel Laboratories at Fort Eustis, Virginia completed a preliminary design study which established the feasibility of building an HLH in the 20 to 30 ton payload range. Impetus toward development of such an aircraft was provided not only by the success of the CH-54 in Southeast Asia, but also by the Soviet Union's introduction of the Mil-12 (Homer) in the late 1960's. The Mil-12, which has a 19-ton payload capacity, demonstrated that engineering problems associated with scaling to large rotor systems and dynamic components was within the technical state-of-the-art. After Congress expressed an interest in an HLH that would satisfy both Army and Navy requirements, DOD approved a program in September, 1970 which specified joint development of an HLH design oriented to satisfying the needs of each service. (17: Notes) The proposed HLH would be used to conduct airmobile operations, delivery of containerized and palletized supplies, loading and unloading of containerships from off-shore locations, and

positioning of ammunition, POL, and other logistics requirements. Its payload range would substantially exceed the current capability of operational Free World helicopters. (26:1)

Advanced Technology Components Program

The program was initially approved as an Advanced Technology Components Program (ATC) to design, fabricate and preliminary test critical HLH components in order to verify technical feasibility and performance acceptability before system development. Selection of this course of action was in consonance with Deputy Secretary Packard's guidance to clearly establish the level of technical risk involved prior to large scale committment of funds to weapons acquisition programs. The Request for Quotation for the ATC was issued to industry in November 1970. (21:1) It included features requiring competitive hardware demonstration as a means of insuring that contractor feasibility studies were sound, that the system could be reasonably well defined, and that cost proposals were credible.

The original Army intent was to fund two or more contractors to build and test critical components of an HLH system. However, after reviewing the five proposals submitted by the helicopter industry, the development of the components was assessed to have a lower risk than originally thought. DOD opted not to proceed with a competitive technology program on the basis that its $100 million cost could not be justified to Congress. In FY 72, Congress appropriated funds for the Army (as lead service) to proceed sole source with Boeing Vertol to develop and test the high risk components of a proposed multi-service tandem rotor HLH. (16:2)

In June 1971 the Army awarded a cost-plus-award-fee contract to Boeing Vertol for $67 million with the following specific objectives: (10:10)

a. Demonstrate component technology to reduce development

risks applicable to a 22.5 ton HLH at lowest systems cost.

b. Secure a cost data base adequate to assure that cost estimates using that data base are credible and acceptable.

c. Provide the government with improved technology and reduced risk for program definition for large payload helicopters.

d. Advance the level of industry expertise in HLH components.

The ATC program involves technical investigation and prototype construction of twenty selected components. Typical of the component work packages is the rotor propulsion system development. It is anticipated based on projected payload that the gross weight of the HLH will approximate 120,000 lbs., more than 2½ times that of the CH-54. Hence, the specifications for rotor blade design are much more stringent particularly in stiffness and size than blades used on today's operational helicopters. At the onset of the ATC program Boeing engineers felt that utilization of boron and graphite composite materials offered the best design solution because of superior stiffness qualities and lighter weight. However it was subsequently determined that each blade would require almost 1000 man-hours to produce and consume 200 lbs. of very expensive graphite in the manufacture. The composite materials would necessitate a complex blade root end for structural integrity upon mating to the rotor hub. Within the past year extensive redesign and testing was pursued that led to construction of a much less expensive and simpler blade. Costly graphite ($75 per lb.) was replaced with a combination of fiberglass ($7 per lb.) and titanium-nickel alloy. Manhours to produce were decreased by 20% with minimal weight penalty. Initial testing indicates that the new design will also possess substantially improved ruggedness and wear characteristics. (17:Notes)

A contractor data package has been prepared for each of the twenty items to include component description, a discussion of evaluation factors, assessment of the impact of item weight and other characteristics on other sub-systems, and a monitoring chart

depicting technical and design variations in terms of their impact on gross weight. Revisions to these data packages are submitted quarterly to the Army Program Manager at the U.S. Army Aviation Systems Command (AVSCOM). In addition, Boeing submits monthly technical performance reports discussing proposed and actual progress on each ATC project. Technical accomplishments are measured in terms of test results, drawing releases, status of on-going testing and design, and future milestones. Additionally, the contractor conducts bi-weekly program reviews which Government personnel may attend as observers. (10:27-30)

A formal Government review of the ATC Program is held quarterly at Boeing Vertol. At this meeting attended by Army and Navy representatives, the contractor presents the technical accomplishments of each ATC project for the interim period. He also presents an overview of each project including reasons for cost, schedule and technical performance variances and corrective actions initiated. The minutes of these meetings are subsequently forwarded to the HLH PM for approval. (10:30)

As of mid-April 1973, the ATC Program was 55% complete and 1.6 weeks behind the schedule approved at program inception. All tasks are scheduled for completion by mid-1974. The contractor is predicting no cost overrun and satisfactory accomplishment of all technical objectives and projects. The HLH PM reported at the mid-April 1973 briefing to the CG, U.S. Army Materiel Command that 50.8% of the incremental award fee potential to date had been earned by Boeing Vertol. The CPAF contractual provisions vary from a base of 3% to a maximum of 9%. Minimal satisfactory performance earns only the base fee. Thus, the contractor is presently collecting over 6% fee, indicating excellent technical progress. (17:Notes)

Prototype Program

In November of 1972, Deputy Defense Secretary Packard

approved initiation of the HLH Prototype Program, and a parallel engine development effort. (26:2) The purpose of the somewhat austere program is to test the technology gains achieved in the ATC effort in an environment which will give DOD the opportunity to examine the flight behavior of an HLH at least commitment of funds. The prototype engine program will provide the base for potential follow-on low risk development and qualification of the engine. DOD decision to proceed into prototype flight test was based upon the generally satisfactory progress experienced on the ATC Program. (26:2,5)

In January 1973, Boeing Vertol and the Allison Division of General Motors Corporation were awarded contracts for the respective prototype HLH and engine developments.. Additional funding in the amount of $70.6 million was authorized for this joint effort. It is presently intended that Boeing will build and fly one prototype during the Validation Phase. First flight test is planned for the period June-December 1975, with DSARC II, the decision point for entering Full Scale Development, scheduled for February 1976. If program go-ahead is approved at that milestone, the current plan is to construct and flight test four additional prototype HLH during FSD which would commence during the 3rd quarter of FY 76 and continue through FY 1980. Production initiation, assuming successful FSD, is planned for FY 1981. (16:1,2)

Technical performance requirements for prototype test have been stated in terms of performance bands to allow maximum trade-off against cost and schedule during the development. The primary performance bands are shown below along with the target values specified in the amended Development Concept Paper and the Material Need document. (26:3)

Requirement	Target	Band
Payload (0-4000 ft @ 95°F)	22.5 tons	20.25 - 29.2 tons

Requirement	Target	Band
Mission Radius	50 NM	35-70 NM
Mission Reliability (2 hour mission)	.97	.90 (minimum acceptable)
Maintenance Man-Hrs per Flight Hour	25	15-30

Estimates of Full Scale Development costs and production unit flyaway costs will be based upon data from the initial prototype program. This data will not be available until the end of FY 1975. However, a tentative "design-to-cost" goal of $5.9 million per aircraft has been established based upon a total procurement for all services of 250 helicopters. The design-to-cost goal will be measured in constant FY 1973 dollars. (16:2)

The Development Concept Paper reflects a planned total DOD production of 233 helicopters. Recent informal estimates indicate that the eventual production buy may be much lower than that figure, perhaps as low as 100 aircraft. The Project Manager, based upon recent guidance from the CG, USAMC, is preparing revised preliminary cost estimates against this lower figure. (17:Notes)

Army and Navy HLH Programs

Early in 1970, prior to DOD approval of ATC Program go-ahead, a joint Army-Navy working committee was formed to study the feasibility of developing a single HLH that would satisfy the requirements of both services. The Army originally desired an HLH with a 25 ton lift capability to insure that essential logistic mission of lifting the standard Mil-Van container would not be compromised. The Navy requirement was for a payload of 18 tons, but under different mission conditions. In reality, the Army HLH with a 25 ton lift capability would be almost twice the size of the Navy proposal. The committee concluded that a compromise 22.5 ton HLH would meet minimum Army

needs but would not be fully compatible with the shipboard requirements of the Navy. (10:8) It was projected that an HLH with this payload capacity would deny its use on service force, amphibious assault and landing platform dock ships because of its size. Nevertheless, in view of Congressional interest in a single HLH that would satisfy the purposes of each service, DOD opted to approve the program as a joint development, commencing with the investigation of critical components. Navy rebuttal of this decision was unsuccessful until the proposals from the five bidding contractors were evaluated in the spring of 1971. (10:12) The Source Selection Advisory Council concluded that none of the proposed designs were compatible to Navy needs at the specified 22.5 ton payload.

The decision to proceed with only one HLH was modified by OSD in May 1971, concurrent with ATC contract award. The Army was instructed to proceed with the development of the Joint or DOD HLH to satisfy the land based HLH missions of all services, and the Navy was to proceed to develop the CH-53E (payload 16 tons) to satisfy the Navy shipboard mission. The DOD decision to authorize an additional program has been the source of considerable Congressional criticism, but in the FY 73 budget approval of the concept was granted, and funds for both the HLH and the CH-53E programs were provided.

CHAPTER V

CONCLUSIONS

(1) The basic objective of Army acquisition strategy is to obtain both adequate quality and sufficient numbers of new weapons systems at affordable prices in today's environment of austere defense funding. Unless both the cost and the performance variables of acquisition can be optimized, the Army may well find itself confronted with a serious capability shortfall in weaponry when compared with future systems of potential enemies. Design-to-cost will continue as an overriding consideration for all major development programs for the forseeable future because of the increased pressure for greater allocation of the nation's resources to solve social and environmental problems, and a corresponding pressure to reduce defense expenditures. All reasonable actions should be taken to insure that the basic tenets of current strategy are understood and applied whenever appropriate throughout the development cycle on all Army acquisition programs. Costly excesses in optimizing the performance variable alone may lead to program cancellations if not completely justified.

(2) During the preceding four years the Army has considerably improved its acquisition processes to meet today's stringent demands for improved performance at minimal costs. Revisions to former requirements documentation have provided Project Managers with greater flexibility during the development to conduct essential cost/technical trade-offs within established thresholds. Improvement in coordination across the CDC/AMC user-developer interface has strengthened requirements definition and provided for more realistic assessments of the risks associated with extending the state-of-the-art on new developmental programs.

(3) The quality of acquisition management has been improved through upgrading of selection criteria for Project Managers and stabilization of duty tours to coincide with completion of critical program milestones. However, the criteria could be further improved by requiring PM-designates to have demonstrated acquisition management proficiency in a previous assignment.

(4) The Cheyenne helicopter program was the victim of the ill-fated total package procurement concept. This method of contracting did not provide the Army with sufficient visibility or program control for effective correction of the technical and cost overrun problems encountered in a program of such complexity. The inflexible QMR performance specifications compounded the managerial difficulties and imposed schedule slippage through the absence of any trade-off mechanism other than lengthy Government-contractor formal reviews. The ongoing development for an Advanced Attack Helicopter is based upon lower technical and cost risk, and should provide a capable new aerial weapons platform for close support of Army ground forces. The AAH program embodies the acquisition principles delineated in DODI 5000.1.

(5) The Heavy Lift Helicopter program incorporates several innovative techniques designed to decrease cost and technological risks. Initiation of a pre-development Advanced Technology Component program has substantially reduced technical risk while providing credible cost information upon which to base the follow-on effort. The success of the components program has resulted in approval for a limited prototype flight test program to verify that the technology is indeed in hand prior to commitment to production. The HLH program serves as a classic example of the "fly before buy" concept of system acquisition.

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