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THESIS

A CASE HISTORY OF THE UNITED STATES ARMY RAH-66 COMANCHE HELICOPTER

by

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March 2000

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A CASE HISTORY OF THE UNITED STATES ARMY RAH-66 COMANCHE HELICOPTER

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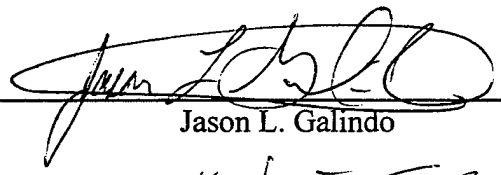
Authors: 
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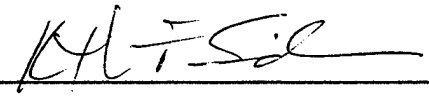
Approved by: 
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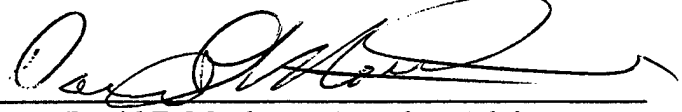
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ABSTRACT

The RAH-66 Comanche Helicopter was initiated as the Light Helicopter Family (LHX) in 1982 when an Army Aviation Mission Area Analysis (AAMAA) identified the need for an armed reconnaissance aircraft. Eighteen years later, the program has yet to reach a Defense Acquisition Board Milestone II review.

This thesis described the history of the RAH-66 Comanche Helicopter acquisition program during these years. The research focused on the question of what significant events and issues have occurred over the course of the Comanche's development that have allowed it to remain a viable program. The research draws several conclusions from the analysis of the Comanche's history. Mainly, despite the significant duration of the program, a valid need for an armed reconnaissance platform still exists. Secondly, the innovative program management of Comanche has maintained a positive reputation for the program. Finally, the loss of Comanche at this point in time would severely impact the defense helicopter industrial base.

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I. INTRODUCTION

A. BACKGROUND

Military acquisition is often characterized by the media and other reporting agencies as inept, wasteful, and mired in oversight at every level. [Ref. 1] [Ref. 2] [Ref. 3] This perception is legitimized by the failure of a few highly-visible procurement attempts, such as the Army's SGT York, Division Air Defense (DIVAD) weapon. [Ref. 4:p. 27] However, the acquisition of modern weapon systems is both a highly complex and resource-intensive affair. It is not uncommon for acquisition programs to span several years and cost American taxpayers billions of dollars.

As an acquisition category (ACAT) ID program, the RAH-66 Comanche Helicopter is one of the largest Department of Defense acquisition programs. Long heralded as the Army's top acquisition priority, the Comanche Helicopter first began life as the Light Helicopter Family (LHX) in 1982 when an Army Aviation Mission Area Analysis (AAMAA) identified the need for an armed reconnaissance aircraft. [Ref. 5:p.1] Eighteen years later, the program has yet to reach a Defense Acquisition Board Milestone II review. [Ref. 6:p. 1]

This thesis will attempt to document the past eighteen years of program history and identify the significant issues, events, and actions taken by Program Managers, the Army, and other Government agencies, that allowed the program to maintain its status as the centerpiece of Army Aviation modernization. The story of how Comanche was conceived, structured, restructured, and managed during a period in which not only the United States, but also the world, witnessed enormous political and social changes, is of great importance to those who would manage or oversee future defense programs. The need to understand and appreciate the history of the program and the significant events and decisions associated with its management, is critical for government officials involved in the planning, budgeting, and reporting of DoD programs.

Historian Wood Gray wrote that when studied, history leads to understanding and wisdom. [Ref. 7:p. 1] People strain to place an event or situation into a continuing process so as to develop some understanding of where they have been and where it is they might be going. When they can place events into a time perspective, they can then begin to develop a perspective of what has happened in the past and how it affected the future. In so doing, they learn from their experiences.

Dr. John Tosh believes that historians and their readers look for two types of guidance from history: To discover lessons learned from events that have occurred before; and to develop a picture of where they as people, stand in time and what the future may hold for us. [Ref. 8:pp. 1-10] For our purposes, it is the former that applies to a study of the Comanche's history. Collectively and individually, people strive to learn from their past mistakes, as well as their successes. The ability to accomplish this by looking back across many generations is what sets people apart from other species and "enables him to better understand the present, in order to prepare himself to face the problems of the future." [Ref. 7:p. 6]

B. RESEARCH QUESTIONS

The primary research question of this thesis is: What significant events and issues have occurred over the course of the RAH-66 Comanche program that have allowed it to remain a viable program? The subsidiary research questions are as follows:

1. What is the history of the RAH-66 Comanche Helicopter Acquisition Program?
2. What was the Army's initial acquisition strategy for the Comanche program and how has it evolved?

3. What innovative measures were taken by the Program Manager in the development of the aircraft?

4. What lessons can be learned from studying the history and development of the RAH-66 Comanche Helicopter program?

C. SCOPE AND METHODOLOGY

The scope of this case study is limited to the period of the program from the original Mission Area Analysis in 1981 through present day. Utilizing this historical database, the study will analyze the significant events affecting the program and the actions taken by the Comanche Program Managers, as well as those of the Army and Congress, that enabled the program to maintain its overall viability and longevity.

The methodology used in this thesis is a historical case analysis of the RAH-66 Comanche program history. To conduct this case analysis the author conducted personal and telephonic interviews with past and present personnel from the Program Management Office (PMO) and the Army's Comanche TRADOC Systems Management (TSM) Office. He also conducted a site visit to the PMO and TSM facility to discuss past and present program issues, and performed a literature search of available program-related documents, books, magazine articles, and other library information resources relating to the RAH-66 Comanche.

D. ORGANIZATION OF STUDY

Chapter I. Introduction: Identifies the focus and purpose of the thesis as well as the primary and subsidiary research questions.

Chapter II. Background of Army Aviation: Provides the reader with a concise history of post-Korean War Army Aviation history and doctrine, as well as the capabilities of the current fleet of reconnaissance and attack helicopters in the Army inventory.

Chapter III. The Acquisition Process: Provides the reader with an abridged explanation of the process by which DoD conducts its acquisition business.

Chapter IV. History of the RAH-66 Comanche Program: Discusses in chronological order the history of the Comanche program, highlighting the significant issues and events.

Chapter V. Analysis of Program Issues and Events: Analyzes the significant issues and events of the program history and the actions of the key players involved.

Chapter VI. Conclusions and Recommendations: Summarizes the findings of the research and answers the research questions.

E. BENEFITS OF THE STUDY

This thesis will document the history of the RAH-66 Comanche acquisition program, and through historical analysis, describe the significant events and issues responsible for its longevity and viability. By understanding why certain events transpired, how they affected the program, and the resultant actions taken on behalf of those events, DoD officials can then begin learning from the past. As the noted philosopher George Santayana proclaimed: [Ref. 7:p. 6]

> When experience is not retained, as among savages, infancy is perpetual. Those who cannot remember the past are condemned to repeat it.

II. BACKGROUND

> The helicopter is aerodynamically unsound. It is like lifting oneself by one's boot-straps. It is no good as an air vehicle...No matter what the Army says, I know that it does not need any. Unnamed Air Force General, 1950 [Ref. 9:p. 1]

A. INTRODUCTION

This chapter establishes the Comanche's place in the historical context of Army Aviation, and provides the necessary information to contrast the aircraft with the Army's current inventory of reconnaissance and attack helicopters. The chapter provides the reader a brief history of Army Aviation, from the separation of the Army Air Corps after World War II, through the growth periods of the Korean and Vietnam Wars, and into the final decade of the Cold War, when the LHX concept was born. Finally, the chapter will furnish a brief description of the Army's current fleet of reconnaissance and attack helicopters.

B. ARMY AVIATION HISTORY

Despite what senior Air Force officers may have said regarding helicopters, the last fifty years provide clear evidence of the tactical and strategic value of this "aerodynamically unsound" air vehicle. Almost immediately after its divorce from the Army, the Air Force began to see

its role in future conflicts as one of strategic aerial warfare. Even during the final days of World War II (WWII), when it was still known as the Army Air Corps, it seemed reluctant to provide the dedicated close-air support required by soldiers on the ground. The Army had little choice but to search for its own solution, which it found in the form of small observation and cargo airplanes and helicopters. [Ref 9:p. 3]

1. Establishing a "New" Army Air Corps

In the period immediately following WWII, the Army purchased its first helicopters, fifty Bell Helicopter OH-13 Sioux. Initially unsure of how to employ the new aircraft, the Army would quickly realize the tremendous potential of rotary-winged aircraft during the impending Korean War. The obvious choice was to use them as aerial artillery spotting platforms or resupply vehicles for units isolated in remote areas. However, aerial medical evacuation of wounded soldiers became their greatest contribution. By the end of the war, more than 21,000 wounded servicemen were evacuated by the Army's rotary-wing workhorse, the H-13 Sioux. [Ref 10:p. 87]

The Korean War had demonstrated the helicopter's unique ability to neutralize the effects of mountainous and rugged terrain on the soldier. The Army's use of small helicopters to hover up and down the

slopes of difficult terrain, and the Marines' limited use of their larger CH-19 Chickasaw helicopters to transport small units into combat, gave rise to a new and evolutionary concept known as airmobility. [Ref. 11:p. 5]

2. Airmobility Doctrine

As the Army began to develop this new doctrine, the theory known as airmobility began to expand. Major General James M. Gavin, the G-3 at the Department of the Army, directed the development of tactical doctrine for the combat employment of helicopters. [Ref. 11:p. 5] His belief that warfare on a nuclear battlefield would require rapid movement of troops and equipment placed special emphasis on the helicopter. Specifically, Gavin believed that cavalry operations such as reconnaissance, screening, exploitation, and pursuit, would be critical on the future battlefield, and best performed by a combination of armed, troop-carrying, and cargo helicopters. [Ref. 9:p. 6] His vision and ingenuity would result in Field Manual (FM) 57-35, "Army Transport Aviation-Combat Operations," which detailed the basic cavalry tactics and techniques that would be proven in combat during the Vietnam War. [Ref. 11:p. 5]

In April of 1962, the Army Tactical Mobility Requirements Board, popularly known as the Howze Board (named for the board's president,

General Hamilton H. Howze), recommended sweeping changes to current Army force structure by converting five of its sixteen active divisions to airmobile divisions. These new divisions would utilize organic helicopters and fixed-wing aircraft in place of many surface vehicles. [Ref. 12:p. 1]

3. Vietnam: A Different Kind of War

The Vietnam War provided a real test for both the Army's new airmobile doctrine and its reliance on the helicopter as a primary weapon to defeat the enemy. The challenging terrain and lack of an established road network fixed traditional armored units and legitimized airmobility. [Ref. 9:p. 14] When asked how the war would have been waged without helicopters, General William C. Westmoreland, Commander Military Assistance Command, Vietnam responded: [Ref. 13:p. 10]

> We would be fighting a different war, for a smaller area, at a greater cost, with less effectiveness. We might as well have asked, What would General Patton have done without his tank?

Despite the eventual outcome of the war, it was a watershed event for Army Aviation, as helicopters became an integral part of how the Army would plan and conduct military operations over the next three decades. However, in the 1970s, the concept of airmobility was not

welcomed on the mechanized battlefields of Europe, which had become "increasingly dominated by firepower." [Ref. 9:p. 33]

4. The Attack Helicopter Becomes King

The new voice of Army Aviation, Brigadier General William Maddox, in his struggle to overcome what he saw as aviation's foremost challenge, credibility with the mechanized army, chose the attack helicopter, dedicated to the anti-tank mission, as Army Aviation's primary focus for the future. [Ref. 9:p. 34] In 1972, the Joint Attack Helicopter Instrumented Evaluation, known as the Ansbach Trials, was conducted to determine the effectiveness of attack and observation helicopters in the anti-tank role. AH-1 Cobras, armed with the new Tube-launched, Optically-tracked, Wire-guided (TOW) Anti-tank Guided Missile (ATGM) and assisted by observation helicopters used as scouts, proved to be very effective. [Ref. 9:pp. 24-25] The role of observation and attack helicopters on the modern battlefield was now solidified.

During the 1980s, a change in the Army's doctrine from "Active Defense" to "Airland Battle," provided Army Aviation the opportunity to expand its limited, although important role. The Active Defense philosophy of the previous decade focused on the effect of firepower and the ability to destroy as many enemy tanks as possible. [Ref. 9:p. 22]

Airland Battle stressed the importance of maneuver warfare, placing the right amount of firepower at the appropriate time and in the most critical location. Because of the helicopter's inherent mobility, this new doctrine greatly benefited Army Aviation's struggle to remain relevant.

Today, attack helicopters remain the centerpiece of the branch. Their role as a maneuver force similar to the air assault and air cavalry forces of the Vietnam era has gained them new respect and acceptance in modern U.S. military doctrine. [Ref. 9:p. 57]

C. CURRENT HELICOPTER INVENTORY

The current fleet of reconnaissance and attack helicopters is a mixture of old and new technologies that illustrate a distinct contrast in capabilities. The OH-58 remains relatively unchanged from its Vietnam War heritage, while the OH-58D and AH-64 represent the latest in rotorcraft technology. The AH-1 and OH/AH-6 have both been extensively modified over the last 30 years through the use of technology insertion. Nevertheless, they have nearly reached the limits of simple modernization without significant airframe modifications such as was done with the OH-58D. [Ref. 14]

1. OH/AH-6 Cayuse

The Hughes Tool Company OH-6 Cayuse and Bell Helicopter OH-58 Kiowa were both direct results of studies conducted during the 1950's to determine light helicopters requirements. The Continental Army Command (CONARC) stated the need for an inexpensive reconnaissance helicopter to replace its aging fleet of H-13 and H-23 aircraft. [Ref. 15:p. 1] The aircraft requirements included: Simple to use, easy to maintain and camouflage, operable from unprepared airfields in forward areas, and single-pilot operable at low altitudes with an observer or passenger. [Ref. 16:p. 206]. These aircraft are significant because they were the first aircraft purchased directly by the Army. Prior to this, the Air Force or Navy were responsible for procuring all Army aircraft.

Today, only a handfull of specially-modified OH-6 aircraft remain in Army Special Operations units, although they bear only a superficial resemblance to the original aircraft. Two variants are known to exist, the AH-6J attack helicopter (see Figure 1) and the MH-6J insertion and extraction transport. They posses a fully-articulating five-blade main rotor and four-blade tail rotor, which combine to significantly reduce external noise and, depending on configuration, allow for a top speed of 130 - 150 knots. Armament choices range from the M134 7.62 mini-gun

and BEI Hydra 70mm rocket pods, to the Stinger missile. Cockpits are equipped with state-of-the-art multifunctional displays, a complete navigation package, and Forward-Looking Infrared (FLIR). [Ref. 17]

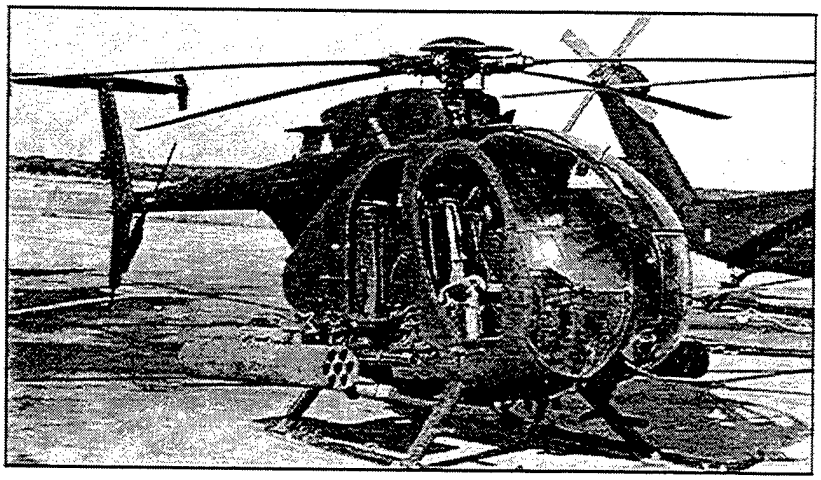

Figure 1. MD AH-6J Cayuse [Ref. 17]

2. OH-58 A/C Kiowa

Originally a losing participant in the Light Observation Helicopter (LOH) competition of 1965, the Bell helicopter OH-58 (see Figure 2) won a new lease on life when Hughes drastically raised the price of its OH-6 during contract negotiations for subsequent procurements. This forced the Army to reopen a new competitive bid process for a light helicopter. Eventually, Bell would sell over 2200 OH-58A/C helicopters to the Army. [Ref. 18]

Figure 2. Bell OH-58 A/C Kiowa [Ref. 18]

The original aircraft, nicknamed "Kiowa," was first delivered to the US Army on May 23, 1969. Later that year, the Army began fielding the Kiowa to units in Vietnam. Little has changed with the aircraft over the past three decades. The design includes an unsophisticated two-blade, semi-rigid, seesaw-type main rotor, one Allison turboshaft turbine engine, modest avionics, and room for two crewmembers and two passengers. Later versions of the aircraft included an upgraded engine, tail rotor, and avionics. Its top speed is around 120 knots. While provisions for light weapons systems were available, the Army did not routinely operate the aircraft in those configurations. [Ref. 18]

3. AH-1 Cobra

One result of the 1962 Howze Board was the recognition that the Army's new airmobile concept would require the fire power of armed helicopters to serve both as escorts for observation helicopters and troop-

laden utility aircraft and as mobile artillery. [Ref. 11:pp. 22-23] Initial attempts at arming utility aircraft already in the Army's inventory, such as the venerable UH-1 Huey, were only moderately successful. Weighed down with weapons and ammunition, the armed UH-1B (and later UH-1M) struggled to keep up with the much faster troop-carrying Hueys. It was clear that a new armed aerial platform, designed exclusively as an attack aircraft, was required. Thus was born the requirement for the Army's first dedicated attack helicopter. [Ref. 10:p. 114-115]

The AH-1 Cobra (see Figure 3) was unique in that it shared many of its major components, including the engine and all of its drivetrain, with the Army's workhorse, the UH-1. [Ref. 10:p. 120] The cockpit was designed with tandem seating, which featured the pilot sitting behind and slightly above the copilot/gunner. Stub wings were mounted on each side of the fuselage, providing hardpoints for storage of weapons such as 2.75-inch Folding Fin Aerial Rockets (FFAR). The nose of the aircraft housed a slewable turret with a 7.62mm machine gun and a 40mm grenade launcher. Top speed exceeded 120 knots. [Ref. 19]

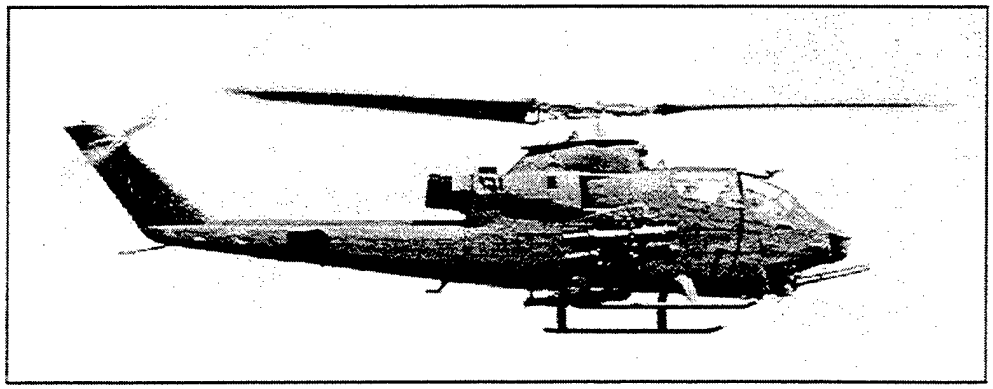

Figure 3. Bell AH-1F Cobra [Ref. 19]

4. OH-58D Kiowa Warrior

In 1981, Bell Helicopter received a contract, through the Army Helicopter Improvement Program (AHIP), to modify the Vietnam-era fleet of OH-58 A/C aircraft with advanced optics and sensors. [Ref. 20:p. 203] The result was the OH-58D Kiowa AHIP. While bearing some resemblance to its older sibling, the new Kiowa became a truly modern helicopter. Improvements included replacing the antiquated seesaw type main rotor with a four-blade composite rotor system and a new, more powerful engine. These changes significantly increased aircraft performance. The most noticeable change, however, was the addition of a mast-mounted sight housing a thermal-imaging system, low-light television, and a laser range finder/designator. [Ref. 21] While the older aircraft relied on its pilot's unaided eye to locate the enemy, the OH-58D Kiowa was now assisted by high-powered optics.

In September 1987, fifteen specially modified OH-58D's participated in Operation Prime Chance, a military action in the Persian Gulf against Iranian high-speed gunboats. These aircraft, known as Prime Chance variants, were rapidly armed with a combination of Stinger air-to-air missiles, Hellfire anti-tank missiles, a 0.50 caliber machine gun, and seven tube 2.75-inch FFAR pods. Their success led to the Army's current variant, the OH-58D (I) Kiowa Warrior (see Figure 4). [Ref. 21]

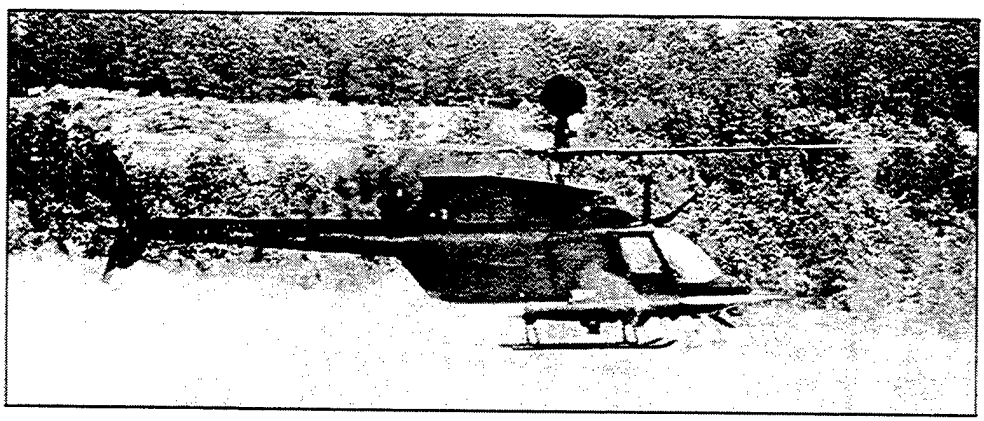

Figure 4. Bell OH-58D Kiowa Warrior [Ref.. 21]

The success of the aircraft also led to a change in its combat role. Initially intended for unarmed reconnaissance and target designation, the Kiowa Warrior now fills the armed reconnaissance role in air cavalry units, and the attack helicopter role in the Army's light divisions. In both cases, it replaces the Vietnam era combination of OH-58A/C and

AH-1F helicopters. The original AHIPs began retrofit and remanufacture into the armed version in fiscal year (FY) 1993. [Ref. 20:p. 203]

5. AH-64 Apache

The AH-64 Apache (see Figure 5) is the Army's most advanced attack helicopter, capable of carrying up to sixteen Hellfire missiles or a combination of missiles and the 2.75-inch FFAR. Additionally, the Apache carries a 30mm cannon in a turret under the fuselage. [Ref. 22:pp. A1 - A4]

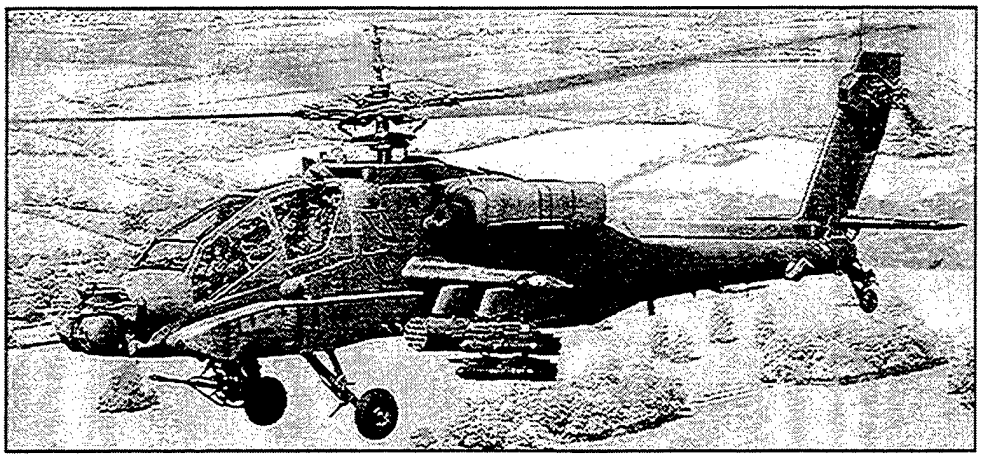

Figure 5. Boeing AH-64A Apache [Ref. 23]

Prior to the advent of the Apache, attack battalions were equipped with the OH-58A/C Kiowa and the AH-1 Cobra Helicopters. These two aircraft complemented each other well, working together as scout/weapons teams to conduct attack operation. When the Apache was fielded, it was intended to replace the Cobra and continue working

with the Kiowa as a scout/weapons team. It was quickly realized, however, that the capabilities of the Apache far exceeded those of the Cobra, and that the Kiowa's deficiencies in terms of speed and optics, only served to degrade the effectiveness of the Apache. [Ref. 24]

The Apache still needed a scout helicopter; however, it was clear the Kiowa was not the answer. The Army's ultimate solution was to be the Comanche. Unfortunately, that result was still several years from being realized. The interim solution was to allow the Apache to perform both the scout and gunship roles. [Ref. 24]

D. THE RAH-66 COMANCHE

The RAH-66 Comanche (see Figure 6) is the Army's planned replacement aircraft for the OH-58, OH-6, OH-58D, and AH-1 helicopters. Comanche will be incorporated into the air cavalry and reconnaissance units of every division and corps, and into the heavy division and corps attack helicopter battalions, as the scout for the AH-64 Apache helicopter. It will also fill the Army's attack helicopter role in the light divisions. [Ref. 25]

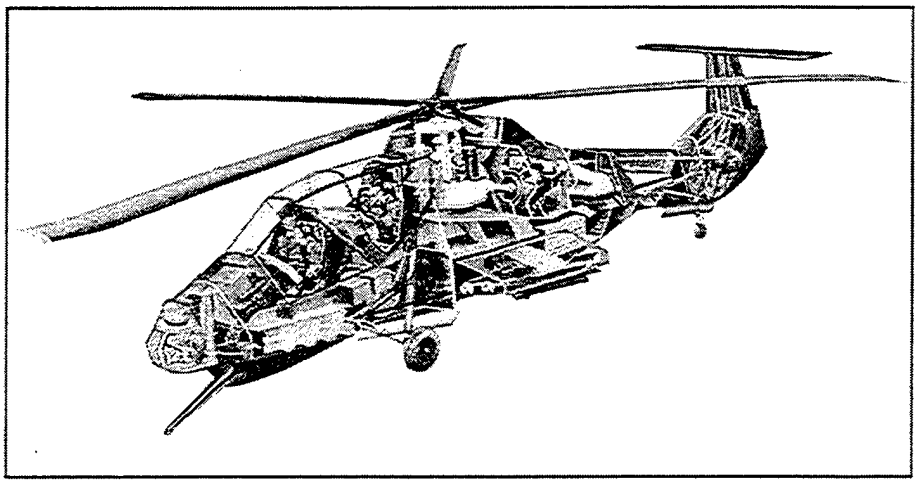

Figure 6. Boeing Sikorsky RAH-66 Comanche [Ref. 26]

The Comanche provides a dramatic increase in combat effectiveness and survivability by addressing the major deficiencies in the Army's current fleet of light helicopters. Those deficiencies include: Tactical and operational obsolescence, marginal night and adverse weather capabilities, high operating costs, and poor survivability, reliability, and performance. [Ref. 27:p. 4]

General requirements for the reconnaissance variant of the Comanche have remained stable despite the lengthy development process. The Army plans for the Comanche to be a lightweight, low-cost, advanced technology helicopter with the primary mission of performing armed reconnaissance, while possessing an embedded air combat capability. [Ref. 27:p. 4] Comanche is a two-seat, twin-engine aircraft capable of performing reconnaissance and attack missions both day and

night, and under conditions of reduced visibility, low ceilings, smoke, dust, and snow. [Ref. 28]

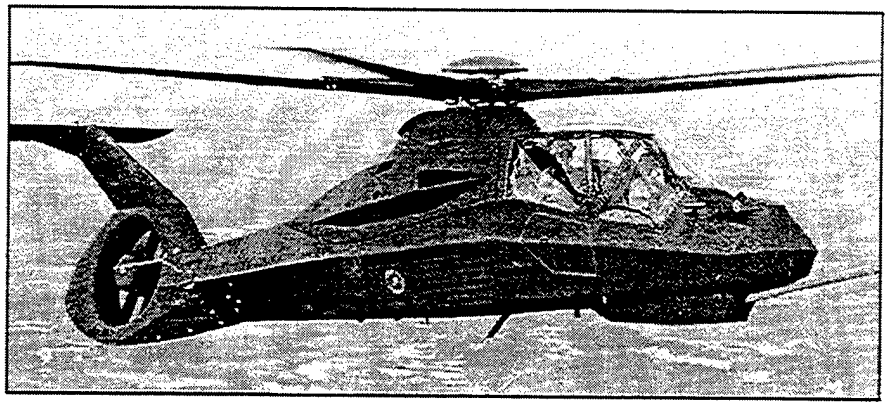

Figure 7. Boeing Sikorsky RAH-66 Comanche [Ref. 29]

The aircraft is unique in that its construction centers around an all-composite airframe (see Figure 7), enabling the Comanche to achieve a radar cross section 630 times smaller than that of the AH-64 Apache and 250 times less than the current, and much smaller, armed reconnaissance helicopter, the OH-58D Kiowa Warrior. This capability is achieved through the use of composites and other measures, such as retractable landing gear, flat and canted body sides, an enclosed tailrotor called the fantail, and internal weapons storage bays. [Ref. 30:p. 35] To reduce the infrared signature of the aircraft, an innovative exhaust system was designed to run internally down the length of the tail boom so that cool ambient air can mix with the exhaust before it is vented beneath the aircraft on either side of the tail. [Ref. 32:pp. 22-23]

The Comanche will be equipped with a suite of passive sensors which include: Long-range, second-generation FLIR, a television targeting sensor, and an upgraded, miniaturized fire control radar similar to the Longbow Apache radar. [Ref. 31] With the computing power equivalent to four supercomputers, the Comanche's onboard systems will provide sensor data fusion and high-speed analysis and correlation. Battlefield information is displayed to the crew via multifunctional displays. Communications and data transmission will be conducted with state-of-the-art dual anti-jam VHF-FM and UHF-AM "Have Quick" tactical radios. [Ref. 26] The program is attempting to achieve significant cost savings through maximum commonality with the Air Force's F-22 Raptor avionics program. [Ref. 26]

The Army's original intent was to build an integrated armed reconnaissance helicopter, an idea that was and still is considered unique. As such, the Comanche is equipped with the ability to carry a combination of missiles, rockets, and bullets. Mounted in a turret below the aircraft is a General Dynamics three-barrel, 20mm cannon with a 500 round capacity. Within its internal, side-opening weapons bays, Comanche can carry up to six Hellfire missiles, 12 Stinger missiles, or 24 Hydra 2.75-inch FFAR. Optional stub wings can be mounted on the aircraft to increase the weapons load or carry auxiliary fuel tanks for

self-deployment. [Ref. 26] In all, the Comanche can go to war with up to 56 unguided 2.75" FFAR, 28 Stinger air-to-air missiles, or 14 Hellfire anti-tank missiles. [Ref. 32:p. 23]

E. CHAPTER SUMMARY

This chapter has discussed the history, doctrine, and equipment of modern Army aviation, beginning with the use of light observation fixed and rotary-wing aircraft during the Korean War. As the helicopter matured in terms of capability and technology, the Army developed Tactics, Techniques and Procedures (TTP) that capitalized on the strengths of the aircraft. Today, the helicopter is an integral component of the Army's combined arms team.

The RAH-66 Comanche is expected to replace four aircraft currently in the Army inventory. With its advanced sensors and optics, combined with survivability and maneuverability not seen before in a helicopter, the Army believes the Comanche will fill a long-standing deficiency in the area of long-range, real-time reconnaissance. Currently, the program is in the Program Definition and Risk Reduction (PDRR) phase of the acquisition cycle. It is scheduled to undergo a MS II DAB review in April, 2000. The current Comanche schedule plans for an Initial Operational Capability (IOC) in 2007.

III. THE ACQUISITION PROCESS

A. INTRODUCTION

This chapter will describe the acquisition process currently used by the Department of Defense (DoD). This description is necessary to understand the management of the Comanche program. The chapter will to explain the acquisition process as it existed in 1982, when Concept Exploration (CE) was initiated with a Preliminary Design (PD) study. [Ref. 28] In order to maintain consistency throughout the thesis, however, current (1999) terminology is utilized. Figure 1 cross-references the old and new terms for each phase and milestone.

B. HISTORICAL PERSPECTIVE

Throughout the 1950s, fears of nuclear war fueled the DoD procurement process, fostering one that ensured superiority by focusing on performance at the expense of cost and schedule. A 1962 study of twelve major defense projects by the Harvard Weapons Acquisition Research Project, determined that, on average, project costs were seven times higher than initially estimated and that development lasted 36% longer than originally scheduled. [Ref. 33:p. 3] The findings and the eventual recommendations of the Harvard Project resulted in a renewed

interest by Congressional and DoD leadership in the acquisition process itself. Over the course of the next several decades, several Executive and Legislative Branch initiatives to improve the acquisition process were undertaken.

In 1985, President Reagan's Blue Ribbon Commission on Defense Management issued a report that established the basis for the current acquisition process. The report was the result of an investigation by an Acquisition Task Force (ATF) headed by Dr. William J. Perry, who would later become Secretary of Defense. The ATF compared government and commercial acquisition systems to find examples of successful acquisition processes that could be used to structure DoD reforms. The result was a group of initiatives that continue to refine and improve the acquisition process by emphasizing commercial practices, while attempting to reduce excessive oversight and regulation. [Ref. 34:pp. 48-62]

C. THE SYSTEMS ACQUISITION PROCESS

OMB Circular A-109, Major Systems Acquisitions, which provides acquisition policy for all executive branch agencies, defines the acquisition process as: [Ref. 35:p. 3]

.... the sequence of acquisition activities starting from the agency's reconciliation of its mission needs, with its capabilities, priorities and resources, and extending through the introduction of a system into operational use or the otherwise successful achievement of program objectives.

Table 1: Acquisition Terminology

Milestone	Phase	Past Terminology	Current Terminology
0			
	0	Concept Exploration and Definition (CE/D)	Concept Exploration (CE)
1			
	1	Concept Demonstration and Validation (Dem/Val)	Program Definition and Risk Reduction (PDRR)
2			
	2	Full-Scale Development (FSD)	Engineering and Manufacturing Development (EMD)
3			
	3	Full-Rate Production and Deployment	Production, Fielding/Deployment and Operation Support
Source: Developed by author			

While OMB's statement is somewhat general, it does infer a process with a definitive beginning: the mission need assessment, and a conclusion: successful achievement of program objectives. DoD Regulation 5000.2-R, Mandatory Procedures for Major Defense Acquisition Programs and Major Automated Information Systems, establishes a model for managing Major Defense Acquisition Programs

(MDAPs). The model is a process of logical phases, separated by milestones (refer to Table 1). Because of the inherent differences in every acquisition program, the model is tailorable to address the conditions of any particular program. The Program Manager (PM) and Milestone Decision Authority (MDA) will ensure the program process flows logically throughout a prescribed set of phases "designed to reduce risk, ensure affordability, and provide adequate information." [Ref. 36:p. 1-1]

1. Mission Needs

Before a service can begin a new acquisition program, it must first identify, document, and validate a mission need through a Mission Area Analysis (MAA). [Ref. 36:p. 1-3] The MAA reconciles the need with the service's overall capabilities, priorities, and resources. If analysis confirms the requirement for a new capability, it is not expresse in equipment terms, but rather in terms of the mission, purpose, capal schedule and cost objectives, and operating constraints. [Ref. 35: Services shall first attempt to satisfy the new mission need by a non-material solution, such as changing tactics, doctrine, or organizational structure. [Ref. 36:p. 1-3]

If a non-material solution is deemed not feasible, a material solution is pursued. The deficiency, described in broad terms, is

translated into a new document, the Mission Need Statement (MNS). [Ref. 37] The MNS explains the results of the MAA and why a non-material solution does not adequately correct the deficiency. It does not address specific performance characteristics or solutions. [Ref. 38:p. 40]

DoD has established categories for acquisition programs to determine the appropriate level of oversight. These acquisition categories (ACAT) range from I to III (with subcategories at level I), and are based on the size and complexity of the program. ACAT I programs such as Comanche, constitute the largest, most costly programs. [Ref. 31:p. 1-2]

Once the requirement for a material solution is validated, requirements developers must consider the most cost-effective solution. Most often, modification of systems already in the Government inventory is significantly more cost-effective than the purchase of new equipment and should be considered first. If modification is not feasible or does not satisfy the requirement, a new acquisition program may be justified. DoD5000.1, Defense Acquisition, lists a hierarchy of material alternatives that must by observed by requirements developers. [Ref. 39:p. 1-6]

After determination of a material alternative requirement, the final MNS is presented to a requirements validation authority for review, validation, and approval. For the largest programs, the Joint Requirements Oversight Council (JROC) is the validation and approval

authority for MNSs. For smaller programs, the chiefs of the military services, heads of defense agencies, and Commanders-in-Chiefs (CINCs) of unified commands validate and approve MNSs. Successful passage through the requirements and validation authority confirms the service's need does exist and that it cannot be met by a non-material solution. It ensures the validation process is complete and the need is valid. Additionally, it will review the document to determine joint service potential. The approved MNS is sent to the MDA for a Milestone (MS) 0 decision. [Ref. 38:pp. 40-42]

2. Milestone 0, Concept Studies Approval

The objective of MS 0 is to determine if the mission need warrants initiation of a concept study. A favorable decision by the MDA authorizes entry into Phase 0, Concept Exploration (CE), but does not constitute program initiation. [Ref. 36:p. 1-6] The MDA will identify the lead organization(s) for the study, the dollar amount, and the source of funding for the study. Finally, a minimum set of alternatives to be examined and the exit criteria for MS I are established. [Ref. 38:p. 47]

3. Phase 0, Concept Exploration

Generally, Phase 0 consists of several competitive, parallel, short-term concept studies. [Ref. 38:p. 48] The focus of these studies is to explore various material alternatives and determine the most promising system concepts. Typically, high-risk areas are identified for the most promising system concepts, along with proposed acquisition strategies, initial cost, schedule and performance objectives, software requirements, tradeoffs, and test and evaluation strategies. [Ref. 36:p. 1-4] Finally, prior to the MS I Defense Acquisition Board (DAB) (advisors to the USD(AT&L)) review, a PM is appointed. [Ref. 40:pp. 1-4-1-6]

4. Milestone I, Approval to begin a New Program

MS I marks a critical step, as a favorable decision indicates approval for a new acquisition program and entry into Phase I, Program Definition and Risk Reduction (PDRR). [Ref. 38:p. 48] The objectives of MS I include reviewing the results of Phase 0 and determining if the achieved results warrant program initiation. If so, the PM proposes an acquisition strategy to guide the execution of the program from initiation through post-production support. [Ref. 36: pp.3-3 - 3-4] The acquisition strategy will address methods for attaining the proposed system in the most cost effective manner, by setting aggressive yet achievable cost

objectives, and if necessary conducting tradeoffs between performance and schedule to achieve a balanced set of goals. [Ref. 39:p. 5] Together with the using community, the PM also develops the Acquisition Program Baseline (APB) to document the most important cost, schedule, and performance objectives and thresholds as outlined and described in the Operational Requirements Document (ORD).

5. Phase I, Program Definition and Risk Reduction

Phase I of the acquisition process is characterized by assessment of one or more concept and design approach. A thorough analysis of the advantages and disadvantages of alternative concepts is conducted, to include supportability and manufacturing process design considerations. The ultimate goal of PDRR is to reduce the risk of manufacturing the system, incorporating new and emerging technologies, and supporting the final product. This is accomplished through prototyping, developmental testing, and early operational testing of critical systems, subsystems, and components. Additionally, cost-driver identification, life-cycle estimates, cost-performance tradeoffs, and other analysis are conducted as part of an Analysis of Alternatives (AOA) and as a means to reduce risk, increase operational capability, and establish or update cost objectives. [Ref. 41]

6. Milestone II, Engineering and Manufacturing Development Approval

As with MS I, this milestone seeks to determine if the performance of the proposed program during Phase I, warrants continuation and entry into the Engineering and Manufacturing Development (EMD) phase. [Ref. 36:p. 1-6] The MDA focuses on program affordability, the national military strategy, and long-range investment and modernization plans to rigorously assess program continuation potential. Because of the significant resource commitment associated with EMD, an in-depth analysis of the identified program risks, as well as the proposed risk management plan is critical. [Ref. 41]

As during MS I, the acquisition strategy is updated and modified as necessary, and approved by the MDA. Additionally, a Low Rate Initial Production (LRIP) Strategy is considered at this time. LRIP involves the production of a limited number of production-configured systems for use in operational tests and confirmation of initial production base capability, as well as the capability for an orderly increase to full rate production. For ACAT I programs, the authority to proceed with LRIP normally requires a separate program review by the MDA, however, this

decision will be made as part of the EMD approval. [Ref. 36:p. 1-4] [Ref. 41]

7. Phase II, Engineering and Manufacturing Development

The primary focus of EMD is to choose the most promising system design and make certain that at the end of EMD, it is a "stable, interoperable, producible, supportable, and cost-effective design." [Ref. 36:p. 1-4] This is accomplished by validating manufacturing and production capabilities and processes, and ensuring the system meets specifications through Developmental Test and Evaluation (DT&E), and is operationally effective and suitable through Operational Test and Evaluation (OT&E). LRIP can begin once all processes are confirmed. [Ref. 38:p. 49]

8. Milestone III, Production Approval

A favorable MS III decision authorizes entrance into production for an ACAT I program and a commitment to manufacture, and deploy the new system. Once again, revised APBs and acquisition strategies are approved. [Ref. 38:p. 49] The MDA ensures the system is prepared for production and establishes with the PM, a realistic production APB. The

decision to proceed with full-rate production cannot be finalized until the official test reporting to Congress, is completed. [Ref. 36:p. 1-7]

9. Phase III, Production, Fielding/Deployment, and Operational Support

Formally known as Full Rate Production and Deployment, this phase indicates the system has now entered production, and that delivery to the field, along with the proper support infrastructure, is occurring. The Program Office continues to monitor system status to ensure it continues to meet the user's requirements. Any deficiencies discovered during DT&E and OT&E are resolved during this phase. Follow-on OT&E (FOT&E) may occur in this phase to continue assessing interoperability, quality, and performance. Additionally, as the system ages or technology enhancements occur, the potential for modification exists. Management of these modifications will continue during this phase. [Ref. 36:p. 1-7]

D. CHAPTER SUMMARY

This chapter discussed the process used by acquisition professionals within the DoD to develop, manage, and ultimately field a major weapon system. It is a flexible process designed to allow the PM to

manage a program utilizing the best commercial and military practices available. The next chapter will detail the history of the RAH-66 Comanche acquisition program.

IV. HISTORY OF THE RAH-66 COMANCHE PROGRAM

A. INTRODUCTION

As the 1980s dawned, Army Aviation was experiencing a newfound significance in the Army's emerging Airland Battle Doctrine. Emphasizing combat in depth, mobility, agility, and maneuver, Airland Battle appeared to be tailor-made for helicopters, at least in the eyes of Aviation's senior leaders. [Ref. 9:pp. 35-37] Fielding of the Army's two newest helicopters, the UH-60 Black Hawk and AH-64 Apache, was well under way, and plans for the next generation helicopter were beginning to gather momentum. This chapter will discuss the history of the RAH-66 Comanche program, from its genesis as the Light Helicopter Family (LHX) to the present, the eve of its most recently scheduled MS II DAB Review.

B. REQUIREMENTS DEFINITION

The driving force behind many of the early program decisions lay within the program's Cold War heritage. Concept formulation began with preliminary study efforts undertaken in 1981. Completed in 1982, the Army Aviation Mission Area Analysis (AAMAA) was a comprehensive analysis of the abilities of a mid-1980s friendly force using tactics

commensurate with Airland Battle doctrine, against a projected mid-1990s Warsaw Pact threat in a European scenario. The primary purpose of the analysis was to determine deficiencies in aviation missions, doctrine, organization, training, and equipment. Over 77 major deficiencies and 260 shortfalls were identified with the Army's current light fleet, which at the time constituted 80% of Army helicopters. [Ref. 5:p.2] Major deficiencies included: [Ref. 42]

- Tactically and technically obsolete 30 year old aircraft
- Little or no night and adverse weather capability
- Marginally supportable
- Little or no payload
- No air-to-air capability
- No self-deployment capability
- Not survivable on the future battlefield

In March 1982, senior Army leadership endorsed the AAMAA during an Army Aviation Systems Program Review (AASPR). The review determined that current doctrine was sound, considering the postulated threat of the mid-1990s. Keeping with standard acquisition procedures, deficiencies were examined for possible correction through the least costly, yet effective method. Remaining uncorrected deficiencies were determined to require a material solution. The LHX emerged as the most

viable concept to meet future Army Aviation capability, modernization, and survivability requirements. [Ref. 43:p. 1]

The AAMAA recommended the development of a follow-on scout, attack, and utility aircraft to replace prior to 1995, the OH-58 Kiowa, OH-6 Cayuse, AH-1 Cobra, and UH-1 Iroquois. The recommendation contained plans for a family of aircraft including two variants, an armed scout/reconnaissance and attack (SCAT) version and a utility/observation version. Together these aircraft would complement the Army's newer helicopters, the Army Helicopter Improvement Program (AHIP, now the OH-58D), the UH-60 Black Hawk, and the AH-64 Apache. (Reames p.2) The AAMAA plan required LHX to possess extensive commonality throughout both variants, with common dynamic components, core mission equipment, and subsystems. [Ref. 42:p. 1]

In January 1983, a LHX Special Workgroup was formed to provide a framework for the LHX program. The group consisted of members from six Army organizations, including the Aviation Research and Development Command, Army Aviation Center, Missile Command, Armaments Command, Training and Doctrine Command (TRADOC), and Army Material Command (AMC). The group identified numerous generic technology programs as critical to supporting the LHX development. After only a short time, the group submitted the Justification for a Major

System New Start (JMSNS) to the Department of the Army for approval and inclusion in the Army's Fiscal Year (FY) 1985 Program Objective Memorandum (POM). The JMSNS and its subsequent approval by the Army, justified the need to develop a family of light, fast, highly-maneuverable, vertical lift aircraft capable of operations in the Airland Battle environment of the future. On December 29, 1983, the Deputy Secretary of Defense endorsed the LHX program through approval of a Program Budget Decision (PBD); as a result, the Aviation Research and Development Command in St. Louis formed a provisional Project Office. [Ref. 43:p.1-3]

C. CONCEPT EXPLORATION

The Concept Exploration (CE) Phase was officially initiated with Preliminary Design (PD) study efforts in 1983. [Ref. 28] TRADOC issued a study directive in December, outlining a Concept Formulation Package (CFP) for the LHX. The early efforts of program officials and prospective contractors were considered essential in establishing operational requirements, determining system feasibility, and assessing program risk. [Ref. 5:p.3]

1. Development Contracts

Fixed-price PD contracts valued at $942,500 were awarded 15 September, 1983, by the Applied Technology Laboratory at Ft. Eustis, Virginia, to Bell Helicopter Textron, Inc., Boeing-Vertol (now Boeing Helicopter), Hughes Helicopter (later McDonnell Douglas, now Boeing Helicopter), and Sikorsky Aircraft. [Ref. 42:p. 2] Each company studied potential concepts and designs of derivative helicopters, advanced technology conventional helicopters, and several other advanced configuration aircraft. The contractors completed and submitted their Best Technical Approach (BTA) as a part of these contracts. [Ref. 28]

On December 21, 1983, the Applied Technology Laboratory awarded competitive Advanced Rotorcraft Technology Integration (ARTI) contracts to the four PD contractors and to International Business Machines (IBM). The ARTI studies were initiated to develop a series of designs for an advanced integrated and automated cockpit as well as full-mission, single-pilot SCAT simulation. [Ref. 42:p. 2] The ARTI effort was part of an intensive technology risk-reduction program initiated by the program office. The intent was to determine if the technology necessary for single-pilot aircraft operation in a reconnaissance and attack mission profile existed. The result was a determination that, in

several situations, the workload inside the aircraft required one pilot to operate the aircraft and another to coordinate operations. To reduce the risk associated with single-pilot operations and because the probability of mission accomplishment in a dual station aircraft was higher, the Army made the decision to develop a two-pilot aircraft that would be single-pilot operable. [Ref. 5:p. 4]

ARTI contracts were expanded in 1985, to include PD of both electro-optical (EO) systems and very high-speed integrated circuit (VHSIC) electronics. [Ref. 42:p.2] Risk reduction contracts awarded later that year to the joint venture of Boeing Helicopters and Sikorsky Aircraft, and to the McDonnell Douglas Helicopter Company and Bell Helicopter Textron Inc., focused on the high-risk areas such as design and testing of the aircraft's advanced avionics, dubbed the Mission Equipment Package (MEP), airframe wind tunnel testing, and engineering simulations. [Ref. 28]

The purpose of the contracts was to allow the contractors to develop and demonstrate, through "bread-board" and "brass-board" demonstrations, critical technology areas such as the VHSIC mission computer, electro-optical target acquisition sensors (EOTAS), pilotage system, and Helmet-Mounted-Display (HMD) subsystems. [Ref. 42:pp. 2-3] In addition to these Government-mandated areas, each team pursued

additional risk-reduction efforts based on its own assessments and as part of the program office's overall risk-reduction program. [Ref. 28]

2. Trade Off Analysis

The Trade Off Analysis (TOA) was a detailed analysis of potential design concepts and potential alternative systems capable of fulfilling the Army's requirements. A total of five separate alternatives were considered. The TOA also addressed design characteristics such as: Aircraft configuration, one versus two operators, survivability, reliability and maintainability (RAM), and schedule, risk, and cost factors. The TOA was completed in 1985 with findings for both the SCAT and utility variants that included: Twin-engines, high-speed helicopter or tiltrotor aircraft, capable of day, night, and adverse weather operations from a fully automatic, two-crewmember cockpit. Advanced features such as fully integrated EOTAS, passive and active survivability features, and joint service capable communications and navigation equipment were also included. Armament for the SCAT aircraft included the newly developed Radio Frequency (RF) fire-and-forget anti-tank missile. Both variants would receive Stinger air-to-air missiles and a turret-mounted cannon of at least 20mm bore. The TOA was instrumental in the design of the LHX during the early phases of the program. [Ref. 5:p.3-4]

3. Formation of the Program Office

The LHX program was initially managed by a small number of individuals assigned to the U.S. Army Aviation Research and Development Command in St. Louis, Missouri; however, in December, 1983, a provisional program office was formed. As a result of the merger between the Aviation Research and Development Command and the aviation portion of the Troop Support and Aviation Material Readiness Command, the LHX program office was subsequently assigned to the Aviation Systems Command (AVSCOM) in 1984. On January 16th 1984, the first LHX Program Manager (PM) was assigned and on October 31st, the Program Management Office (PMO) was officially established. A FY85 manpower authorization voucher authorized seven military and forty-seven civilian technical and management positions. [Ref. 43:p. 3-4]

The first PM, a Colonel with a Bachelor of Science degree in Industrial Engineering and a Master of Science in Mechanical Engineering, did not have an extensive background in the acquisition field. His previous experience included only three-and-a-half years at Department of the Army Headquarters monitoring weapon systems development. Due to the significant visibility of the program, he would maintain the title of PM for only a short period. However, his legacy

would be the LHX's baseline acquisition strategy, which would guide the program for many years to come. [Ref. 43:p. 3]

In August, 1984, the Under Secretary of the Army and the Vice Chief of Staff of the Army appointed a new PM, Brigadier General (BG) Ronald K. Andreson. The move was made in part due to the high-visibility and importance of the LHX program; however, Andreson's background also made the decision appropriate. He had a Bachelor of Science Degree in Engineering and Masters in Aerospace Engineering. The general's previous experience included serving as the PM for one of the Army's newest helicopters, the UH-60 Black Hawk. His most recent assignment was serving as AVSCOM's Deputy Commander for Research and Development.

BG Andreson's charter as PM, approved March 28, 1985, gave him significant autonomy. In particular, it stated that the PM reported directly to the Commanding General of AVSCOM, and that he had the full line authority of the Commanding General of the Army Materiel Command. According to Andreson, this level of independence did not exist when he was the PM for the Black Hawk. [Ref. 43:pp. 3-4] This autonomy would have a direct impact on the innovative management approach that BG Andreson and subsequent PMs would take with Comanche, and will be discussed in more detail in chapter V.

4. Baseline Strategy Formulation

As industry wrestled with the LHX concepts, the Aviation Systems Command (AVSCOM), began assessing potential acquisition strategies. A trade-offs determination (TOD) board conducted in 1983 also explored several strategies. [Ref. 43:p. 6] The goal was to develop a strategy that could satisfy LHX requirements within an acceptable degree of risk. Several low-risk strategies were analyzed, including both an EMD fly-off of SCAT aircraft with a FY92 production goal, and a completely hands-off approach by the Government. The eventual baseline acquisition strategy, however, was deemed lowest risk.

Acquisition plan number one, approved on August 12, 1984, established the LHX baseline acquisition strategy. This approach called for the LHX to enter production no later than FY90. [Ref. 44:p.3] To meet this ambitious timeline, the previously mentioned joint ventures were scheduled to begin the Engineering and Manufacturing Development (EMD) (formally Full-Scale Development) phase in FY86, following a combined MS I/MS II (formally Defense Systems Acquisition Review Council - DSARC) decision in October of 1985. The air vehicle fly-off was scheduled for FY89, with the winner entering production shortly thereafter. Program goals included: [Ref. 44:p.3]

- 7500-8500 lbs. primary mission gross weight for SCAT.
- $5 million average unit flyaway costs in FY84 dollars.
- 70% commonality between SCAT and utility aircraft versions.
- 50% reduction over the AH-1/UH-1 in average maintenance man-hour per flight hour.
- 25% improvement in fuel economy over AH-1/UH-1 T-53 series engine.

This baseline strategy provided a foundation upon which subsequent strategies would build as circumstances evolved.

5. A Fluid Acquisition Strategy

Almost immediately after publication, the LHX baseline acquisition plan came under fire. Specifically, the Army's attempt to field LHX in the first years of the next decade required rapid acceleration of the acquisition process. Because of that, the program would not undergo a discrete MS I decision; instead, it combined the CE and PDRR phases, and planned for a joint MS I/II decision to enter EMD. Upon further review of the proposed strategy, the DoD Inspector General believed the Office of the Secretary of Defense (OSD) was misled and in fact believed the program, as briefed to OSD, did in fact contain two discrete MS decision points. The Army maintained that OSD endorsed the combination strategy by approval of the service's FY85 POM. Despite the

eventual outcome supporting the Army's position, the confusion was indicative of the early schedule problems the program would face. [Ref. 43:pp.14-15]

Over the next three years, the LHX acquisition strategy would undergo several adjustments in an attempt to further reduce program risk, and manage increasingly constrained budgets. In 1985, several risk-reduction contracts were cancelled due to funding constraints. In an effort to reduce the technical risk associated with the loss of those contracts, the PM revised the baseline strategy. The basic competitive contractor teaming strategy remained. However, EMD was stretched out to 60 months; and production was scheduled for FY92. The additional time allowed for expanded contractor risk-reduction efforts in the areas of concept formulation, one-pilot cockpit proof-of-concept, and preliminary system design. [Ref. 44:p. 4]

By July, 1986, the second acquisition strategy was deemed unaffordable. Despite a Defense Science Board recommendation to maintain competition throughout EMD, the PM was forced to adjust the program to remain within POM funding guidance. The revised strategy split EMD into two phases. Phase I, entitled Detailed Design, called for competition between contractor teams, through the use of Firm Fixed

Price (FFP) contracts. At the end of Phase I, the program would down-select to one team and continue developmental efforts. [Ref. 44:p. 6-7]

By 1987, the LHX acquisition strategy, an ever-developing document, only vaguely resembled its 1984 progenitor. Concerned with system maturity and overall costs, OSD officials continued to object to the program decision to conduct a joint MS I/II decision. As such, the newest acquisition strategy acknowledged concern over the compressed time-frame by transitioning CE into a fifty-six month PDRR phase beginning in FY88. The intent for a now discrete PDRR was to allow the program more time to reduce cost, schedule, technical, and performance risk. PDRR requirements included: [Ref. 42:p.3]

- Contractor teaming, with competition between teams.
- Three dual-station prototypes per team, each with single-pilot capability
- Core MEP on flight prototypes
- Full MEP on a ground-based avionics prototype
- Integrated training system
- Contractor and Government developmental testing

EMD, scheduled for 26 months, would begin after a successful MS II decision and down-selection to one contracting team. A fixed-price contract award was planned for September 1992, and Low-Rate Initial

Production (LRIP) contract award for November 1994. A separate EMD for the assault variant was scheduled to begin in December 1995 and last for 35 months. The 1987 program strategy allowed for fixed price competitive development and production contracts. PD contractors joined together to create two competing teams, each with a single design that both members of the team could eventually produce individually. This approach would allow the PM to compete production contracts between the team members, starting with lot 3. [Ref. 42:pp. 3-4]

Along with the significant strategy adjustment, 1987 also marked the passage of several program hurdles. The Operational Requirements Document (ORD) (formerly known as Required Operational Capabilities (ROC) document), and the first LHX Analysis of Alternatives (AOA) (formerly known as Cost and Operational Effectiveness Analysis) were released. Additionally, the program's MS I DAB review was scheduled for right after the Christmas holidays in January, 1988. [Ref. 5:p.5]

a. Operational Requirements Document

In 1987, the United States Army Aviation Center (USAAVNC), representing the using aviation community, produced the official ORD detailing the desired operational requirements. It confirmed the necessity to replace existing light reconnaissance and utility fleet and

thus correct existing deficiencies. The ORD addressed key system characteristics the using community felt were vital to fielding a new aircraft. They included: [Ref. 5:p.5]

- Single airframe for both scout and attack mission.
- 1260nm self-deployability capability with a 30 minute fuel reserve.
- Transportability requirement to fit within Air Force C-141, C-17, and C-5 aircraft.
- Improved hot day performance (at 4000 ft and 95 degrees Fahrenheit) over current light fleet.
- Increased speed and endurance of 170 knots (kts) at intermediate rated power (IRP).
- Improved survivability through reduced visual, aural, and IR signatures and crashworthiness (vertical impact of 38 feet per second)

TRADOC approved the ORD along with a proposed Operational and Organizational plan on March 11th, 1987. [Ref. 25] The TRADOC Deputy Chief of Staff for Doctrine acknowledged the importance and inherent difficulty in performing the reconnaissance mission and informed USAAVNC that fixing Army reconnaissance deficiencies must be the number-one priority. He directed LHX requirements to place emphasis on the aircraft's reconnaissance and attack capabilities. [Ref. 5:p. 5]

b. Analysis of Alternatives

An AOA for the LHX began in 1985 and was completed in March 1987. The AOA was a comprehensive analytical effort conducted to determine the most cost and operationally-effective alternative replacement to the AH-1, OH-58 A/C, and UH-1 aircraft. Its release in 1987 coincided with the upcoming MS I decision scheduled for 1988. The analysis considered every facet of operations and support requirements, to include threat, operational employment, logistics, man-machine interface, training, and cost. [Ref. 5:pp.5-6]

Current and developmental variants were included in the alternative analysis. The four system alternatives included: [Ref. 44:p.9]

- Alternative 1 - AH-1+ (+ indicates Reliability, Availability, and Maintainability (RAM) and safety product improvements), OH-58 A/C+, and UH-1+
- Alternative 2 - AH-64+ (+ includes operational improvements), OH-58C+, and UH-60+
- Alternative 3 - LHX scout, attack, and utility helicopters
- Alternative 4 - Tiltrotor scout, attack, and utility aircraft.

Each alternative was modeled in the current Air Land Battle doctrine, concentrating on a mid-intensity European Warsaw Pact scenario. In addition, a Southwest Asia scenario was also modeled against second-tier Soviet equipment. [Ref. 5:p. 5] The AOA concluded

that existing aircraft could not be economically modernized, and therefore alternatives one and two were dismissed. The advanced technology helicopter and tiltrotor aircraft both demonstrated substantial improvements in key areas such as survivability, deployability, sustainability, supportability, and cost of ownership. However, concern over tiltrotor technical feasibility and developmental costs led to a decision to support alternative three, development of an advanced technology rotorcraft. [Ref. 45]

The month following release of the AOA, OSD expressed concern over the lack of a definitive selection for the LHX design and directed that independent studies be conducted to confirm the results of the original analysis. Both the RAND Corporation and the Institute for Defense Analysis (IDA) conducted independent analysis of the LHX issue, assessing the capabilities and appropriateness of the four Army alternatives. An advanced helicopter design was confirmed by both organizations to be the most operationally-effective alternative and the design with the lowest 20-year lifecycle costs. [Ref. 5:p. 6]

It was now clear that the future of LHX would focus on a conventional helicopter capability. While tiltrotor proponents would criticize this decision for its lack of vision, the program would undergo a battery of reviews confirming the Army's choice. [Ref. 46]

6. Milestone I

What started out as an event-filled year ended with the realization that the LHX program, as structured, would be difficult and expensive to attain. As Congress began its annual budget debates in 1987, the LHX program was confronted with a skeptical Congress. Key members of the House Armed Services Committee, such as ranking Republican Representative William L. Dickinson, voiced strong concern over the Army's willingness to fund LHX by cutting back on the previously planned production of Black Hawks and Apaches. As a result, the final FY88 Appropriations Bill only allotted $70 million of the $267 million requested for development for the LHX. [Ref. 47:p. 421]

The effect of House budget decision was felt in January 1988 when the program underwent an Army Aviation Modernization DAB review, chaired by the USD(A), Robert B. Costello. The purpose of the board was to review the status of the LHX program as well as the Army Aviation Modernization Plan about which Congress had expressed concern. The board determined that under the current and forecasted budgets, the Army could not afford the LHX. [Ref. 48:p. 20]

Citing problems with affordability, the Acquisition Decision Memorandum (ADM) signed by Deputy Secretary of Defense

(DEPSECDEF) William H. Taft, informed the Army that the LHX is "no longer a viable program" and that it should refocus to develop and acquire a low-cost, light-weight scout/attack aircraft. The PM was given until the end of the upcoming summer to prepare for a new MS I DAB review. Developmental efforts were directed to focus on an austere PDRR and to emphasize risk-reduction efforts in the MEP development. [Ref. 48:p. 20] Any desires the Army had of developing a family of helicopters ended when the DEPSECDEF eliminated the utility version of the LHX from the acquisition plan. [Ref. 5:p. 6]

Program officials immediately began to adjust their program focus, centering on the near-term milestone of a summer DAB. The revised acquisition strategy emphasized contractor risk reduction efforts by better defining MEP architecture and requiring demonstrated performance of key MEP components, such as the TAS, 2d generation FLIR focal plane array, and high resolution day (TV) sensor. Competitive 18-month (later changed to 23-month) PDRR contracts awarded to both teams of contractors required design and engineering of preliminary aircraft mockups and major systems such as drivetrain and flight control systems. Due to budgetary constraints, the revised strategy would not require a flyoff between competing designs. However, substantiation of proposed aircraft design and key system performance through "bread"

and "brass-board" demonstrations, testing, and simulation was required. [Ref. 49:p.247] Down-select to a single contractor team would occur at the end of PDRR and precede a planned 69-month EMD phase. [Ref. 44:p. 12]

The LHX program received a successful MS I decision in June 1988. The Government awarded a cost-plus-fixed-fee (CPFF) contracts to Boeing/Sikorsky and McDonnell/Bell contracting teams in November for $167,124,000 and $167,818,000, respectively. The approved schedule included source selection of one contracting team and a MS II decision in December 1990, first flight in August 1993, and Initial Operational Capability (IOC) in November 1996. Estimated R&D costs in FY89 dollars were $3.3 billion. Production costs were expected to run over $24 billion for a reduced purchase of 2096 aircraft. [Ref. 50:p.24-28] Congress's support for the restructured program as well as the Army's Aviation Modernization plan had apparently returned, as it approved all of the $125 million requested in the President's FY89 budget. [Ref. 51:p.669]

D. PROGRAM DEFINITION AND RISK REDUCTION – THE EARLY YEARS

While 1987 had ended on a pessimistic note, 1988 ended with the program in a solid position. The DAB approved program entry into PDRR, and contracts were issued to both competing teams in June. Congress supported the Army's Aviation Modernization plan and the LHX program during the last round of budget debates, and the Boeing/Sikorsky team unveiled its preliminary design in October. [Ref. 52:p. 31]

As 1990 approached, the dawn of a new decade brought with it, among other things, a new era of relaxed U.S. – Soviet Union relations, which presented OSD with extensive challenges. The fall of the Berlin Wall and German reunification were just two of the tremendous events that transpired to redirect the Pentagon's direction and focus. President George Bush and his Secretary of Defense, Richard Cheney, were faced with the challenge of both reaping the benefits of winning the Cold War, and maintaining a healthy defense budget.

1. Major Aircraft Review

The changing world order prompted the Secretary of Defense to instruct the Pentagon to conduct a Major Aircraft Review (MAR) in June

1990. The intent of the MAR was to assess the affordability and requirement for several major defense systems, among them the recently renamed LH (formerly LHX). The results, validated by the JROC, confirmed previous assessments of Army Aviation deficiencies; however, it also directed more program restructuring. [Ref. 5:p.7]

The SECDEF required an extension of PDRR for two additional years, and contract modifications to allow for complete testing of the prototypes prior to entering EMD. The effects of the SECDEF decision deferred MS II and production for two years, slipped IOC from 1996 to 1998, and further reduced the total aircraft purchase from 2,096 to 1,292. [Ref. 44:p.14] The program slippage was an apparent attempt by the SECDEF to allow additional time to prove-out critical system components, and once again reduce overall funding commitments.

2. PDRR Prototype Phase

On April 12, 1991, after an extensive source selection process, the Army awarded a cost-plus-incentive-fee with award fee (CPIF/AF) PDRR prototype contract to the Boeing/Sikorsky contractor team. The PDRR prototype contract period of performance was scheduled for 52 months, with an option for a 39-month EMD phase. Milestones for this phase included prototype first flight in August 1994, and IOC in December

1998. The total number of aircraft was expected to be 1292. [Ref. 44:p.15] The contract included provisions for four prototypes, plus a static test article (STA) for MEP testing, and a propulsion system test-bed (PSTB) for testing all dynamic components on the aircraft. [Ref. 26] On the 15th of April, the Army officially designated the LH as the reconnaissance and attack RAH-66 Comanche. [Ref. 44:p.15]

The purpose of the Comanche PDRR prototype phase was to finalize the aircraft design and to manufacture prototypes. Comprehensive flight and static system testing were to demonstrate system maturity and assist in reducing risk. The scope of the program was limited to PDRR activities, with a focus on the design, engineering, and supportability of the total system requirement. The original program goals represented design constraints for the contractor. [Ref. 44:p.15]

The far-reaching effects of the dissolution of the Warsaw Pact and the Soviet Union became markedly evident in the first few years of the new decade, as the President and SECDEF struggled to balance shrinking budgets and ambiguous national security requirements. In an attempt to ensure the future of U.S. military technological superiority, the SECDEF announced during the budget preparation of 1992, that the Pentagon would continue to fund development of next-generation weapons. However, support for development did not guarantee support

for production. As a result, the new Comanche PM, BG Orlin Mullen, was directed to continue research and development of the aircraft, but to defer indefinitely any plans for production. [Ref. 53:pp.20-22]

3. 1992 Restructure – REPLAN I

The impact of the SECDEF's directive was both familiar and significant. Renewed emphasis was placed on proving-out all critical components, including the avionics, T800 engines, and Longbow millimeter-wave radar fire control system. [Ref. 44:p. 17] The prototype phase was increased by over two years, from 1995 to 1997. Prototype production fell from four to three, and the static test-bed was cancelled altogether. The first prototype flight was pushed out one year to August 1995 [Ref. 53:pp. 20-21] The Army lost the pricing arrangements negotiated in its April 1991 contract, including the option to transition the program into EMD. [Ref. 44:p. 19]

Final approval for the new acquisition strategy was granted in the ADM signed by the USD(A), Donald Yockey, on December 15, 1992. The ADM authorized General Mullen to proceed with the program, subject to the following constraints: The manufacture of three prototypes, flight testing of T800 growth engines, and additional effort on the proposed gun. PDRR phase was now stretched to 78 months (Apr91-Oct97) and

EMD, while not authorized, was planned for 60 months and estimated at $2.882 billion. [Ref. 44:pp. 18-19] In all, the OSD directed restructure would result in an increase of $1.4 billion in RDT&E costs. [Ref. 54]

Almost immediately, the new program began to experience funding shortages. In February 1993, a review of EMD funding requirements highlighted a shortfall of $424 million. The following month, a program budget decision (PBD) decreased FY94 funding for Comanche by an additional $76 million, of which $11.1 million was for inflation reduction alone. Combined with a FY95 reduction of $19 million, the new PDRR prototype phase was under-funded by $95 million. [Ref. 44:p19]

Growing anxiety over the budget shortfall prompted a meeting between the PM and Boeing Sikorsky in September 1993. After having just struggled through a program restructuring, each party was determined to develop a new, less-expensive approach to restructuring the program to fit current budget profiles. Minimal disruption of program operations was critical.

To reduce FY94 spending, the program implemented the following deferrals: [Ref. 44:p. 20]

- Program commonality effort for FY94 and FY95
- Growth engine integration effort

- Training development

Deleted from the PDRR phase was Longbow Radar integration. The deferrals and deletions reduced program spending for FY94 by $65 million. Acknowledging the remaining shortfall, Boeing Sikorsky also announced a schedule slip of three months. Contract completion was now contingent upon future years' funding. [Ref. 44:pp. 18-19]

4. Program Streamlining – REPLAN II

Program officials spent the majority of 1993 attempting to streamline the Comanche acquisition process in an effort to merge PDRR and EMD activities. The intent of the streamlining process was to reduce acquisition costs and expedite IOC. Boeing Sikorsky was directed to assess key areas of the streamlining initiatives, such as preparing program schedules, and providing funding requirements and plans for contractor logistical support programs. Additionally, the contractors were instructed to identify potential commercial approaches that could be applied to the acquisition strategy. [Ref. 44:pp: 20-21]

On February 16, 1994, the Acting USD(A), R. Noel Longuemare, authorized the PM to begin implementation of streamlining initiatives. The authorization limited the PM to "short-term redirection of the PDRR contractual efforts" for FY94 and FY95. The objectives of the

streamlining effort included performing cost-benefit tradeoffs, planning for the production phase, and clearly documented cost reduction analysis based on streamlining initiatives. [Ref. 44:p. 21] General Mullens provided Boeing Sikorsky with specific redirection guidance, for which an additional $5 million was added to the FY94 budget. The tasks included: [Ref. 44:pp. 22-23]

- Stop development of prototype three
- Do not include a reduction in communication capabilities or fail to integrate upgraded capabilities as a result of streamlining
- Provide limited support to Longbow Radar development to ensure Comanche integration requirements are included in its development

On April 25th, 1994 the Boeing Sikorsky team submitted their new plan. A month later, the DAB Conventional Systems Committee (CSC) met to review the streamlined proposal. [Ref. 44:p. 23] The CSC findings were generally favorable. There was some concern, however, that the program was carrying too much risk, due to both concurrency and the accumulation of engineering changes. The PM addressed these concerns by slowing proposed development and production output. The planned production output for FY00 – FY05 is listed in Table 2.

Table 2. 1992 Proposed Restructure Production Output

	Pre 1992 Restructure	Post 1992 Restructure
FY00	0	3
FY01	24	8
FY02	48	10
FY03	96	12
FY04	120	48
FY05	120	72
Source: Developed by author with information from [Ref. 55:p.20]		

The new strategy moved up the first article delivery by one year. The planned first flight was moved from November 1995 to early 1996. [Ref. 55:p. 20]

5. ORD Update

Concurrent with the Program Management Office (PMO) streamlining initiatives, the Comanche TRADOC System Manager (TSM) began converting the original ORD to the new format, as prescribed by DoD 5000.2. A major shift in the National Military Strategy, the breakup of the Soviet Union, changing technology, and lessons learned from recent military operations, all served to validate the need to review and update the six-year-old operational requirement. In all, nine new requirements were added, and twenty-three were changed or clarified. The Army approved the revised ORD on April 28, 1993. [Ref. 5: p. 8]

In 1993, the recently appointed SECDEF, Les Aspin directed a comprehensive analysis of the national defense strategy, as well as the doctrine, force structure, and modernization plans of the four services. Entitled the Bottoms Up Review (BUR), Aspin's analysis identified the Comanche as both a technological and cost risk, due to the significant developmental work still remaining. The BUR advised careful oversight of the program. Nevertheless, it did confirm the criticality of timely battlefield intelligence. [Ref. 5:p. 8]

E. PDRR – THE LATER YEARS

On August 12th, 1994, BG Orlin Mullen retired and Colonel James Snider was appointed as Acting PM. Seven days later, the Deputy Secretary of Defense (DEPSECDEF), John Deutch, directed the Army to develop alternatives that would lead to the termination of the Comanche program. [Ref. 44:p. 23] Despite being described as the Army's number one acquisition priority, Comanche's cost made it a high-profile target for cancellation.

The Clinton administration's five-year budget plan for modernization alarmed senior Army leadership. Of particular concern was the state of the helicopter industry, and the effect program cancellation would have on it. With Black Hawk production scheduled to

end in 1996, the industry would have no new military aircraft in production. The Principal Deputy to the Assistant Secretary of the Army (RDA), Lieutenant General William Forster, emphasized in a 1994 interview that Army modernization budgets had steadily dropped and would have required a FY96 budget increase of $600 million to fund current modernization plans. [Ref. 56:p. 102]

In October, the USD(A), Dr. Paul Kaminsky, directed Colonel Snider to implement the streamlining plans as briefed to the CSC by the now retired General Mullen. Specific instructions included: [Ref. 44:p. 24]

- Updating the AOA to measure the effects streamlining would have on operational effectiveness
- Performing analysis of system design maturity to ensure RAM and performance thresholds are met
- Developing plans for a second operational test and evaluation of aircraft modified with Longbow Radar
- Preparing an explanation of how the contractor's claim of a 10,000-hour airframe life would be confirmed.

1. Early Operational Capability

Prior to implementation of the streamlining program, the SECDEF issued a December 9th directive to once again restructure the Comanche program. Largely attributable to DEPSECDEF Deutch, the directive was

part of a larger package of defense cancellations or restructures and effectively eliminated production of the Comanche. Deutch's move was intended to ease Army budget pressures. However, faced with the possible cancellation of two high-profile systems, the Comanche and the Advanced Field Artillery System, the Army chose to sacrifice the former. [Ref. 57:p. 18]

A PDM, issued on December 16th, restructured the Comanche into an industrial and technology-based program. The program retained the two flyable prototypes from the previous restructure. However, production was deferred indefinitely. Colonel Snider was given until March 30, 1995, to present the restructured plan to the DAB. [Ref. 44:p. 25]

As part of developing a sound acquisition strategy, one compliant with the December 16th PDM, Colonel Snider met in Seattle, Washington, with the Aviation Program Executive Officer (PEO), Major General DeWitt T. Irby, the ASA (RDA) Gilbert Decker, and the Army Chief of Staff, General Gordon R. Sullivan. Determined to develop a strategy that would sustain the program in the near-term, and if funding became available, allow it to transition into eventual production, the group sketched out a plan to salvage the Comanche.

The resultant plan, dubbed the Early Operational Capability (EOC) program, was rooted in their belief that if the program could manage to provide the Army with a portion of the aircraft's capabilities, the program would in turn sell itself to OSD and the Army. Colonel Snider felt that by demonstrating the program's ability to produce an aircraft, even one with reduced capabilities, senior policy makers and Army leadership would see the value of the program, and once again support funding it into production. [Ref. 46]

The EOC plan continued development of the Comanche, and provided, by 2001, for the manufacture of six aircraft for test and evaluation. [Ref. 56:p. 104] The EOC aircraft would not be production-model aircraft, but they would be capable of demonstrating at a reduced level, flight and reconnaissance capability. Armament systems would not be included, nor would the aircraft have the advanced targeting system included in the MEP. Most importantly, the accelerated development program would be accomplished within the reduced budgets. [Ref. 46]

On March 16th, 1995, the CSC was briefed on the EOC details. The CSC approved the EOC plan and recommended approval to Dr. Kaminsky. On the 21st, Dr. Kaminsky approved the newly restructured program and the exit criteria for MS II. [Ref. 44:p. 25]

The new program schedule included awarding an EOC contract in January 1997, with aircraft delivery in late 2001. Development of the MEP was divided into two phases. Phase one provided for development of the reconnaissance sensors to be integrated into the EOC aircraft. Phase two involved development of the weapon systems and was deferred until the 2000-2003 timeframe. Reconnaissance capable EOC aircraft were scheduled, beginning in 2002, to take part in a two-year operational test. By 2004, the aircraft weapon systems would be integrated. Initial Operational Test and Evaluation (IOT&E) was scheduled for 2005-06, and IOC was now scheduled for 2006. [Ref. 30:p. 36]

On January 2nd, 1996, Boeing Sikorsky and Government personnel began writing the Statement of Work (SOW) and the performance weapon system specification, using an "Alpha Contracting" approach[1]. [Ref. 44:p. 25] Contract negotiation continued throughout the remainder of 1996. One area of contention involved $40 million authorized in the FY97 budget that was currently on the Congressional recission list. The result of the lost funding required delaying the installation of several reconnaissance systems from the EOC aircraft into the LRIP aircraft.

[1] Alpha contracting is an acquisition streamlining technique involving the use of teaming (Government and contractor) to prepare, evaluate, and award proposals. The intent of alpha contracting is to substantially reduce the time spent on developing contract proposals using the traditional approach. [Army Acq Reform Guidebook : 14]

The final contract was agreed upon on January 1, 1997, and included two prototypes and six EOC aircraft. Delivery of all EOC aircraft was expected by September 2002. The new contract vehicle was a cost-plus–award-fee (CPAF), with a 10% award fee based on quarterly performance reviews. Total contract value was $3.7 billion. [Ref. 44:p. 26]

Key to the success of the EOC plan was to produce six reconnaissance capable aircraft for early user evaluation, and to achieve this within the same constrained budget. The PM instituted the EOC plan following approval by the USD(A) in March 1995. Concurrent with the strategy shift, the joint venture of Boeing Sikorsky began a public relations blitz. Comanche mockups and simulators began appearing at every major OSD activity. The well-known military fiction writer, Tom Clancy, was given, through advanced simulation, a first-hand demonstration of the Comanche's capabilities. He was so impressed with the system that Boeing Sikorsky enlisted him to speak on behalf of the aircraft and its relevance on the future battlefield. Without payment or compensation, Clancy narrated a promotional film and made several public appearances on behalf of the program. [Ref. 46]

The efforts of the PM and Boeing Sikorsky were rewarded over the course of the next year with a wave of support from Congress and OSD.

On May 25, 1995, Boeing Sikorsky rolled out the first prototype aircraft. [Ref. 26] Later in the year, declaring the President's Army modernization budget did not adequately support the Comanche, and thus jeopardized the Army's future, Congress increased the program's FY96 budget by $100 million, to $299 million. [Ref. 58:p. 9-6]

On January 4, 1996, the Comanche helicopter made its maiden flight. The thirty-six minute flight took place at the Sikorsky Aircraft test facility in West Palm Beach, Florida. [Ref. 30:p. 35] By October, the aircraft had accumulated seven hours of flight-testing, and achieved a forward airspeed of over 100 kts. [Ref. 26] Extensive use of telemetry to transmit and process flight data during the test-flight, allowed for accelerated testing . [Ref. 59] By late 1997, the prototype had logged 62 flight hours and achieved a speed of 170 kts in forward flight, and demonstrated 45 kts in both rearward and sideways flight. [Ref. 26]

2. Pre-production Prototype Program

In mid-July, 1998, the new PM, Brigadier General Joseph Bergantz, became concerned with the EOC program. He sensed in the aviation community a growing disenchantment with the program, as it provided less than optimal (that is, reconnaissance only) aircraft to the user. In particular, there was growing concern that because the aircraft

were not production quality, they would, when fielded, create a poor perception of the Comanche in the minds of the user. The unintended result would be a loss of support for the program. Additionally, a generally favorable opinion of the program at senior OSD levels and in Congress provided an appropriate opportunity to modify the program. [Ref. 59]

As a result, General Bergantz proposed the fifth restructure in program history. The new strategy complied with the same funding constraints placed on the EOC plan, but accelerated the development of the MEP and Longbow Radar. [Ref. 59] The Comanche Pre-production Prototype (PPP) Program required Boeing Sikorsky to produce fourteen aircraft (six pre-production and eight IOT&E) beginning in 2003, a two-year slip from the EOC program. Development of the full armament and reconnaissance MEP, as well as the Longbow Radar, would be expedited and integrated on the PPP aircraft. [Ref. 60:p. 2]

The scope of BG Bergantz's restructure required the aviation community's vote of confidence. The Army would not receive the anticipated EOC aircraft in 2002. Instead, delivery was scheduled to begin in 2003. Additionally, six PPP aircraft and eight IOT&E aircraft would replace the six EOC aircraft. While it appeared the PPP program offered the user significantly more aircraft, the eight IOT&E aircraft were

actually two less than the number originally scheduled for IOT&E. Despite the slip in the schedule, General Bergantz was offering the Army production-configured aircraft, to include the new Longbow radar, (originally scheduled for production lot six) utilizing the existing EOC program funding resources.

The revised schedule anticipated a MS II DAB Review in March 2000, a nineteen-month acceleration. The EMD effort would center on full MEP development, as well as Longbow integration. Four PPP aircraft, one with radar, would take part in a limited user test, scheduled for FY05. Aircraft numbers seven through fourteen, would be production equivalents, and take part in the previously scheduled FY06 IOT&E. General Bergantz briefed the Overarching Integrated Product Team (OIPT) in June 1998, and the program received the approval of the USD (A&T), Dr. Jacques Gansler, on July 27, 1998. [Ref. 60:p. 3-6]

F. CHAPTER SUMMARY

This chapter discussed the history of the RAH-66 Comanche Helicopter program, beginning with the AAMAA in 1981. The program has endured an on-again-off-again relationship with Congress, OSD, and even the Army. A lack of determined support by these agencies has manifested itself into a perpetually adjusting acquisition strategy. The

results can be seen in Table 3, which illustrates the difficulties and impact associated with the program's five restructures.

Table 3. Restructuring Synopsis

	PDRR Begin	EMD Begin	RDTE Cost (ESC $)	IOC	Remarks
Baseline Strategy	None	FY86	$3.2B	FY92	- No PDRR - MS I/II Scheduled for FY86 - Approx. 4500 aircraft
Restructure #1 1988	FY88	FY90	$3.9B	FY97	- Utility variant dropped - 23 month PDRR added to strategy - Down-select scheduled for end of PDRR - Aircraft procurement quantity reduced to 2096 - EMD scheduled for 69 months
Restructure #2 1990	FY88	FY95	$5.3B	FY99	- PDRR extended to 52 months - PDRR two phases: Phase one – competitive development Phase two – Down-select and design completion - Procurement Quantity reduced to 1292 - EMD 39 months
Restructure #3 1992 REPLAN I	FY88	FY98	$6.7B	FY03	- PDRR extended to 78 months - Added Longbow requirement - Prove out all critical components - Prototype quantity reduced from four to three - EMD eliminated but planned for 60 months
Restructure #4 1995 EOC Program	FY88	FY02	$7.8B	FY06	- Longbow broken out and planned as P3I (to FY09) - 6 Reconnaissance capable EOC aircraft, deliverable by FY01 - RDTE extended additonal four years to FY06
Restructure #5 1999 PPP Program	FY88	FY00	$8.3B	FY06	- Cancels EOC aircraft - Accelerates Longbow and MEP integration to first lot - 14 Production quality aircraft beginning 2003
Source: Developed by author; cost data from 1999 PMO Briefing [Ref. 54]					

The table portrays the results of each of the Comanche's five major restructurings. Of significance is the increase of over $4 billion in RDT&E costs. Despite this significant increase, it appears the only real change from the original program is the loss of the utility aircraft, a reduction in procurement quantity from 4,500 to 1,292, the addition of the Longbow radar, and an IOC date that has been pushed back from FY92 to FY06.

The Comanche is undoubtedly a victim of the turbulent acquisition environment of the 1980s and 1990s. However, several elements have combined to keep the program afloat, and even progressing. To begin with, the Army Aviation community has stood firmly in support of the program, and has taken an active role in requirements validation. Secondly, despite the occurrence of five program restructurings, each of them can be linked to affordability issues or as in the PPP program, utilization of best practices. Government and contractor personnel have maintained a disciplined and innovative approach to management throughout the history of the program. Finally, the downsizing of the services has focused attention on the defense industry, and in particular the aerospace industry. This was illustrated by Congressional concern over the Army's aviation modernization plans, and the fluctuation of the Comanche's budget.

In the next chapter, I will analyze the significant events of the program history, and discuss how the program retained its viability and status as one of the Army's primary acquisitions for the 21st Century.

V. ANALYSIS OF SIGNIFICANT EVENTS

A. INTRODUCTION

DoD has been historically criticized for a painfully slow acquisition process. [Ref. 1] [Ref. 2] [Ref. 3] The Comanche, however, appears to have broken new ground in this regard. Few programs that can trace their roots back to 1981 are still waiting to enter EMD. The Air Force's F-22 Fighter, for example, was conceived about the same time as Comanche. It successfully entered EMD in 1991. [Ref. 33:p. 160]

The program's history has been unpredictable if nothing else. The on-again, off-again support for the Comanche has unquestionably resulted in schedule slippages and increased costs. Despite the changing threats, rising costs, and long delays, the Comanche stands at a major threshold. Almost 20 years after its inception, it appears poised to begin a $3.1 billion EMD effort. [Ref. 61] Thus begins a new era in the Comanche program. However, it is the past which is of interest, and begs the question: What is it about the RAH-66 Comanche program that has allowed it to withstand all of the events of its past, and yet stand ready today to face its MS II review?

Three reasons stand out from the prior historical discussion of the program. Each plays a key role in understanding the forces at work behind Comanche. First and foremost, while events in the world have changed the threat facing the Army, its requirement for accurate and timely intelligence, which Comanche is designed to provide, has remained unchanged. Secondly, although both cost and schedule have become an issue with the program, it has been innovative, proactive program management by both government and contractors, which is responsible for keeping the program on track. Finally, without any new military helicopters under development, the Comanche represents the only new development in a dwindling U. S. helicopter industrial base. Its cancellation would leave industry only DoD aircraft modification and production contracts.

B. REQUIREMENTS

In 1982, the AAMAA recognized the deficiencies of the Army's light observation and attack helicopters. It determined, that when placed on a notional 1990s battlefield, the current fleet of light helicopters was tactically obsolete and incapable of performing its wartime reconnaissance tasks. [Ref. 5:p. 2] In particular, these aircraft did not

possess the technology to operate and survive in the high-threat environment envisioned for the future. [Ref. 42::p. 1]

With that understanding, the combat developers began the process of determining the requirements for the LHX and later the Comanche. Doctrine, training, organization, and material solutions were all assessed to determine the most cost-effective resolution to the deficiency. The final determination required a material solution, and thus the LHX program was established.

As the world has changed, so has the Army's approach to defending the interests of the country. However, the need for timely, accurate intelligence data has not changed. Recent operations in Kosovo illustrated an inability for U.S. Commanders to obtain all of the vital intelligence they required, through the exclusive use of satellite imagery, unmanned aerial vehicles (UAV), or fast-moving fixed-wing aircraft. In a prepared statement to the Senate Armed Services Committee, Secretary of Defense, William S. Cohen, commented on lessons-learned from Kosovo. The Secretary stated: "The operation also highlighted the importance of intelligence, surveillance, and reconnaissance -- and the fact that the assets that provide these essential elements of success are in short supply." [Ref. 62] It appears evident, that as the Army prepares to celebrate the 20th anniversary of its formal requirement for a new

reconnaissance helicopter, OSD and senior Army leadership still believe the same need exists today. More importantly, JROC approval and several AOAs indicate the Comanche fulfills those requirements.

1. Comanche TSM

The Comanche TRADOC System Manager (TSM) represents the using community in the development of the RAH-66. By definition, the TSM is responsible for coordinating the efforts of the PMO, user, and trainer in the life-cycle management of a system. [Ref. 62] In the case of TSM Comanche, active participation from the earliest stages of the program has been a key component to maintaining a positive relationship between the using community and the PMO. Equally important, the TSM's participation ensured a sense of joint ownership in the program.

This mutually supportive relationship has created a bridge between the two organizations that has ensured an open channel of communication. The results include relatively stable performance requirements and a consistent level of support from the aviation community. Evidence of this is seen in the following illustrations.

Realizing the importance of establishing a positive relationship with the user, Comanche PMs have made a concerted effort to ensure

TRADOC involvement in program decisions. This included using program funds to guarantee TSM representation at critical program events. [Ref. 14] Additionally, representatives from the PMO and TSM office were based at several contractor locations throughout the U.S. For example, along with several personnel from the PMO, a senior aviation warrant officer and non-commissioned (NCO) officer representing the TSM, were present at the Comanche Developmental Flight Center in West Palm Beach, Florida. Their mission was to provide a resource for the contractor on supportability and operational suitability.

While operational aircraft have yet to materialize, the aviation community has not given up on the program. In fact, program management involvement by TSM personnel has given them a unique insight into the acquisition strategy and a sense of ownership in the ultimate product. The effect of this association has resulted in the aviation community standing firmly behind the Comanche.

2. Requirements Confirmation

From the very earliest stages of program development, the LHX has undergone significant analysis of cost and operational effectiveness factors. From 1985 to 1987, TRADOC conducted the first AOA. The analysis examined various existing and developmental alternatives. The

analysis concluded that both advanced technology helicopters and tiltrotor aircraft presented operationally sound alternatives; however, the tiltrotor was deemed too expensive, and therefore the helicopter was recommended. [Ref. 45]

Expressing concern as to the conclusiveness of the first AOA, the USD(A) required a second, external AOA be conducted on the LHX. The RAND Corporation and the Institute for Defense Analysis were both contracted to perform the analysis. Their conclusions were the same as TRADOC's. It appears evident that in the early stages of the program, government and independent analysis confirmed the advanced helicopter as the proper choice to fulfill the armed reconnaissance requirement. In 1990, a second AOA conducted by TRADOC would conclude with similar results. [Ref. 5:p. 6] The Comanche was clearly the most cost and operationally efficient choice for the Army.

Over the next several years, several OSD level reviews would again confirm the Comanche as the appropriate reconnaissance platform for the Army. In 1990, a Major Aircraft Review (MAR), conducted by OSD, evaluated the requirement for and affordability of Comanche. While reducing the total number of aircraft procured, the MAR did validate the Army's reconnaissance requirement and its choice of aircraft. [Ref. 44:p. 16] Former SECDEF Les Aspin's 1993 Bottoms Up Review (BUR),

confirmed the significant role of reconnaissance during Operation Desert Storm, and the 1997 Quadrennial Defense Review affirmed the necessity of Comanche to implement the Army's Force XXI doctrine. [Ref. 5:pp. 8-9] These final reviews came in the aftermath of the weighty events that occurred in Europe during the 90s. Evidence clearly indicates that the Army's response to correcting its reconnaissance deficiency was the appropriate one.

C. PROGRAM MANAGEMENT

From the beginning, each Comanche PM has struggled to ensure the program remained both well managed and relevant. Despite the turmoil experienced throughout the program's history, the PMs and contractors have managed to keep the program on track in terms of cost and schedule. Key to the program's success has been the use of several innovative management techniques.

1. BG Andreson and the Early Years

As essentially the first PM, BG Andreson enjoyed a relatively more supportive environment than his predecessors. President Ronald Reagan had begun the process of building up America's military through the

acquisition of new and better weapons. Budgets were on the rise and support for Comanche both in OSD and the Army was clearly evident.

Nevertheless, the environment facing General Andreson provided its own challenges. The measures taken by Andreson during these early years set the stage for how the program would progress and how it would be viewed outside of the acquisition community as well as outside of the Army.

An example of Andreson's innovative contributions to the development of the Comanche program was the use of planned competition through both the EMD and Production phases. Competition in EMD was to be maintained between industry teams and would conclude with the down-selection to one team for production. Once in production, the winning team members would separate and compete with each other for subsequent production contracts. Andreson also utilized this technique for the LHX engine, which was to be contracted for separately. Although the drastically reduced procurement quantities presently scheduled no longer make this an affordable option, it sought to maintain competition throughout the lifecycle of the program, and to ensure the lowest cost to the Army. As such, the program initially possessed tremendous appeal as a model procurement program to senior Army, OSD, and Congressional leadership. [Ref. 64:p. 1]

General Andreson's acquisition strategy for the PDRR prototype phase was also a departure from other major system acquisition strategies. Its design provided the teams significant freedom to conduct tradeoffs in the Comanche's development. [Ref. 65:p. 29] Entitled the "Design Flexibility Clause," this acquisition streamlining measure provided the contractor a limited number of PMO and user-defined goals. For example, the Comanche established goals of: [REF. 65:p.29]

- An empty weight of 7,774 pounds,
- A flyaway cost of $9.3 million,
- The use of twin T800 engines.

The PM, user, and contractors reached agreement on performance ranges for empty weight, flight performance, radar detectability, crashworthiness, and ballistic tolerance. [Ref. 65:p. 29] The clause allowed the contractor to make tradeoffs without enduring time-consuming and expensive contract modifications. If, for example, the contractor identified a design-to-cost improvement that improved overall system performance even though it increased aircraft weight, it was permitted to make the change. [Ref. 64:p. 2]] The PM and contractor believed design flexibility provided cost-saving opportunities and assisted

in reducing performance and technical risk without negatively impacting the program.

The contract vehicle provided an incentive to the contractor to carefully manage the Design Flexibility Clause. If performance ranges were breached, the contractor risked loss of award fees. Conversely, if tradeoffs resulted in optimizing the balance between costs and performance, supportability, and producibility, the contractor earned increased award fee. Additionally, the contractor agreed to share in all cost overruns, fix all failures during development, and if necessary, pay for correcting reliability problems using a percentage of production profits. [Ref. 65:p. 29-30]

The Design Flexibility Clause allowed the contractor to perform necessary tradeoffs in order to achieve program goals, as long as performance stayed within mutually agreed upon ranges. This level of autonomy, along with the contract award incentive, placed the contractor in a unique position. Similar to their counterparts in commercial industries, Boeing Sikorsky was no longer responsible for producing what their potential buyer told them to manufacture, but rather for the end product their buyer actually wanted.

2. BG Mullen and Streamlining Initiatives

When BG Mullen assumed the position of Program Manager in June 1991, Comanche was enjoying a brief respite from the turmoil of the first ten years. Prior to BG Andreson's departure, the first milestone had been successfully passed and the PDRR contract with Boeing Sikorsky signed. This fortuitous timing allowed BG Mullen to institute several innovative measures; however, the period of relative calm was short-lived.

a. Teaming

While the history of relationships between DoD and contractors may be characterized as adversarial, the Comanche PM and Boeing/Sikorsky made a concerted effort to develop a "teaming" approach to management. While not the first program to utilize an Integrated Product Team (IPT) approach, immediately following down-selection the Comanche program centered its approach on managing the program around its Product Development Teams (PDTs). A collaborative group of contractors and government experts, the PDTs worked together to solve problems spanning the entire spectrum of design, development, and production [Ref. 64:p. 2]

When combined with advanced computer-based design technologies, the effort has been very effective. The concurrent approach allowed for simplified program communication that assisted in cost-saving ideas and elimination of errors. An example of the PDT efficiency involved the manufacture of prototype number one. Open lines of communication between PDT members and the use of computer-based production parameters, assisted in compensating for the natural confusion created by two companies operating together for the first time. Fabricated on production tooling, the airframe required less than 40 percent of the allocated man-hours.

Even more demonstrative of the teaming benefits was assembly of the forward and aft fuselage sections. Sikorsky manufactured the forward assembly structure in its Stratford, Connecticut plant; in Philadelphia, Boeing had responsibility for the aft fuselage and the shrouded tailrotor. When the components came together for the first time at the final assembly facility, they fit together perfectly. [Ref. 64:p. 2] While advanced computer-aided manufacturing (CAD) was, to a great extent, responsible for the success of this process, the teaming approach utilized by the program office facilitated the cooperation necessary to effectively and efficiently achieve this outcome. [Ref. 45]

b. CTT

Teaming was not confined to the engineering and scientific tasks. Beginning with the down-selection to one contracting team, the Army maintained a role as an integral member of the testing team, advocating both operational and maintenance interests. [Ref. 64] Joining with the prime and sub-contractors, the program office formed the Comanche Combined Test Team (CTT). Through the cohesive effort of each member's test communities, the CTT worked together to plan and execute test programs. CTT members shared in executing test plans (including flight-tests); collecting reliability, availability, and maintainability data; and maintaining a common engineering database. [Ref. 66:p.1]

Combined testing was an innovative initiative intended to integrate government and contractor efforts during the development phase. The methodology was adopted to reduce redundancy in developmental testing between government and contractor test communities, and thus reduce much of the expense and time associated with its execution. The objective was for both parties to jointly conduct a single test and share the resultant data. [Ref. 59]

c. The Environment Turns Threatening

In an effort to stave off OSD level budget reductions, BG Mullen attempted to institute other streamlining initiatives as well. His intent was to merge PDRR with aspects of EMD and thus lower costs and accelerate aircraft production. His effort was only partially rewarded. While a Process Action Team endeavored to find opportunities to streamline the Comanche acquisition process, senior leadership in OSD was considering eliminating the entire program. In October 1994, Comanche won approval from Dr. Kaminski to implement streamlining activities, but in December, DEPSECDEF Deutch issued his directive relegating the program to a technology-based project. It seemed that for every step the program took forward, it took two steps back. Nevertheless, the reputation Comanche earned as a model acquisition program while under BG Andreson, continued under BG Mullen. [Ref. 64:p.1] Despite unstable funding and commitment, the management of Comanche continued to persevere.

3. Early Operational Capability Aircraft Strategy

When Colonel Snider took the helm of the Comanche program, he faced a very threatening environment. The DEPSECDEF had just relegated Comanche to a technology-base program, placing Comanche in

a precarious position. If the program were required to reduce its production effort and refocus only on technology development, Colonel Snider knew it would be a prime candidate for cancellation during every subsequent budget cycle. The decreasing budgets experienced by the Army over the following years would certainly have put the Comanche at risk.

The EOC program was conceived as a result of the environment confronting Comanche. As Snider, Irby, Sullivan, and Decker met in Seattle, Washington, they knew they had little time and limited opportunities to devise a plan to save Comanche. Their belief in the Army's armed reconnaissance requirement, and the Comanche's ability to satisfy it, was at the core of their attempt to find a solution. The consensus was that the program could sell itself, if senior OSD and Army leadership could be made to see its potential. [Ref. 46] Unfortunately, after 12 years and over a billion dollars, the program had little to show. The group believed that a demonstration of the aircraft's abilities would persuade senior leadership that their money had been well spent. Prototype aircraft, originally an integral part of the baseline strategy, might have allayed these concerns earlier; however, affordability constraints led to their cancellation.

Contrasting Comanche with a similar program illustrates the value of developmental prototypes. The Air Force's next-generation fighter, the F-22, began life only two years prior to the Comanche. [Ref. 33:p. 157] As with the Army's advanced helicopter, the F-22 acquisition strategy included the use of prototype aircraft to demonstrate advertised performance qualities, and identify and reduce technical, cost, and schedule risk. [Ref. 33:p. 170] However, budget constraints quickly eliminated this option from Comanche's strategy.

In 1988, OSD concern over affordability forced BG Andreson to restructure his program in order to pass a second MS I review. Constrained budgets forced the PM to cancel prototype construction. In FY88, the Comanche program's annual appropriation included $70 million of a requested $267 million. [Ref. 51] In FY89, Comanche received all of its requested $125 million to support the revised strategy. [Ref. 67] In contrast, for FY88 and FY89, the F-22 received a combined $1.192 billion of a requested $1.239 billion, and was preparing for the development of four prototype aircraft. [Ref. 51] [Ref. 67] While Comanche was receiving approximately 50% of its requested budget, the F-22 was receiving 96% of its request.

By FY92, the F-22 prototypes had successfully flown a total of 157 hours, the program had entered EMD, and its annual budget had leaped

to over $2 billion. [Ref. 33:p. 23] [Ref. 51] [Ref. 67] [Ref. 68] The Comanche on the other hand, did not have any prototypes, was being directed to restructure once again, and to indefinitely defer its production plans.

As the Army program faced possible termination, it could only point to small-scale risk-reduction efforts to demonstrate that the program was progressing. In an interview, Major General Snider (PEO Aviation) stated that one of the more difficult tasks he faced was keeping OSD leadership interested in the program. As individuals rotated through critical OSD positions, they often had little or no appreciation of the program's history. The result was a constant struggle by the PMs to maintain positive program visibility and relevancy. [Ref. 46] While the more important aspect of prototyping may have been risk-reduction, another benefit was a demonstration of program progression to those individuals responsible for funding the program.

Success of the EOC plan rested on two factors: six reconnaissance-capable aircraft had to be produced within the same constrained budget as before; and the Army had to be convinced that this was a good idea. Without flying prototypes to demonstrate the Comanche's value, the program faced a daunting task. The answer came in the form of a tag-team effort to sell the program, by the PM and Boeing Sikorsky.

Few opportunities to promote the Comanche and the new acquisition strategy were missed. The use of mockups and simulators to advertise the futuristic appearance and capabilities of Comanche became commonplace at every OSD activity. Tom Clancy was enlisted to use his considerable popularity with DoD leadership and speak on behalf of the program. For his part, he was so impressed with the system that he assisted without payment or compensation. [Ref. 46]

Snider's gamble on the EOC plan achieved its initial goal of saving the program from the budget axe. The public relations effort of both Boeing Sikorsky and the PM managed to invigorate a floundering support base and put the Comanche back on the Army's priority list.

4. Pre-Production Prototype Program

When BG Bergantz began his tour as PM in June 1997, the program environment could not have been more different from that facing his predecessor. While Colonel Snider was greeted with threats of cancellation, General Bergantz inherited a program enjoying newfound support. Congress had increased the FY97 budget by $49 million to $338.6 million. [Ref. 69:p. 10] The first prototype aircraft, after overcoming some technical difficulties, was steadily expanding its flight

envelope. [Ref. 26] General Bergantz, however, was uneasy with the historically fragile underpinnings of Comanche support.

The EOC plan called for delivery of six reconnaissance-capable aircraft by 2002. In essence, these aircraft would only be partially mission capable, as they would lack the sophisticated target detection, identification, and targeting systems planned for the final production aircraft. Additionally, they would be completely unarmed. General Bergantz's concern was that delivery of these aircraft might have the opposite effect from what was originally intended. Instead of endearing the aircraft to its users, he was concerned the aircraft might focus attention on the tasks the EOC aircraft were not yet capable of performing. [Ref. 59]

To avoid this perception, General Bergantz believed the program strategy must undergo another restructure. This was a difficult decision, based on the instability of past strategies. Nevertheless, his decision to restructure the program significantly altered the near-term program deliverables, and contained some risk.

Like his predecessor, BG Bergantz required the aviation community's vote of confidence if he were to succeed at restructuring the program. While appearing to promise greater numbers and better-equipped aircraft, the PPP plan also delayed, once again, delivery of the

Army's first Comanche. General Bergantz knew he must emphasize that despite a slip in the schedule, the Army would now receive production-configured aircraft, to include the new Longbow radar, (originally scheduled for production with lot six) utilizing the existing EOC program funding resources.

Two factors combined to make General Bergantz's gamble pay off. The first was the favorable atmosphere surrounding the program. Since the inception of the EOC program, the Comanche had enjoyed renewed interest and support. The Army was touting the aircraft as the linchpin of its future digital battlefield plans. [Ref. 70:p. 29] Congressional leaders such as California Republican Representative Robert Dornan, began speaking on behalf of the program. [Ref. 71:p. 9] The program now had a prototype flying, and Boeing Sikorsky had instituted a successful marketing campaign. Influential Congressional and OSD leadership were brought to the West Palm Beach, Florida, flight test center to observe the aircraft first hand, and fly alongside the Comanche while it conducted actual test flights. Clearly, the prevailing atmosphere was receptive to change.

General Bergantz had to convince more than just Congressional and OSD leadership. The second key factor in Bergantz's gamble involved swaying senior Army leaders, and in particular, Army Aviation

leadership, which had been waiting for Comanche since the originally scheduled fielding date of 1996. To many, slipping the schedule another year seemed like just another delay in a series of delays. To ensure support, the PM emphasized the production quality of the aircraft, and offered an additional 1400 flight hours for IOT&E. BG Bergantz' greatest risk, however, was the integration of the Longbow radar into lot one versus lot six. The radar had long been recognized as the highest risk element in the program due to immature technology. However, it was of tremendous benefit to the user, and to BG Bergantz, worth the gamble. Finally, General Bergantz offered to purchase additional simulation and training devices to be used for the development of TTP. [Ref. 59]

The EOC and PPP restructures were two of the most significant factors in maintaining the viability of the Comanche program. While each PM established their restructures under significantly different environments, the results were equally important. Colonel Snider was attempting to save the program from certain death by providing the Army with something the original strategy would have provided if not for budget constraints: Prototypes. General Bergantz was motivated by the concern that a less than optimal aircraft would result in a loss of support for the program. Most important to the success of both strategies was

the ability for both PMs to achieve their considerable goals within the same budget resources.

D. THE INDUSTRIAL BASE

As early as 1994, DoD and the Army in particular began to express their concern over the shrinking helicopter industrial base. The far-reaching effects of downsizing the military included numerous defense industry mergers. In an August 1994, Government Executive article, the Military Deputy to the Assistant Secretary of the Army for RDA, Lieutenant General (LTG) William Forster, stated that current procurement plans would leave a gap in helicopter production. "Given that the commercial helicopter base is already much smaller than it was a decade ago, that means that all our helicopter buys in the future will be very expensive." [Ref. 56:p. 104] The following year, the only factory producing a new aircraft was Sikorsky, with its UH-60 Black Hawk. The bulk of government helicopter contracts were for modifications and upgrades to existing aircraft. [Ref. 72:p. 104]

In 1995, there were four major military helicopter manufacturers. Despite that limited number, SECDEF William Perry was intensifying pressure on the industry to consolidate into no more than two major companies. Perry cited as the culprit for requiring industry

consolidation, a minimum of two additional years of sharply-declining budgets in FY96 and FY97. [Ref. 73:p. 29] By 1997, Boeing and McDonnell Douglas would merge, leaving the industry with only three companies [Ref. 61]

The Comanche represented the only new helicopter program in 25 years. [Ref. 70:p. 34] Its cancellation would leave both the Army and Sikorsky in dangerous positions. Assuming a procurement cycle of just half that of Comanche's, the Army would be well into the second decade of the new millennium before it would begin seeing an answer to its reconnaissance shortcomings.

According to Richard Aboulafia, an aviation industry analyst with the Teal Group, an aerospace and defense consulting firm, Sikorsky would be the biggest loser in the event Comanche were cancelled. Boeing's V-22 Osprey program and AH-64D Longbow Apache remanufacture program represent large, well-supported and fully-funded programs. Funding for Sikorsky's UH-60 Black Hawk rebuild program is not as certain, and faces continuing budget wrangling. [Ref. 74:p. 33]

Even to the casual observer, the impact of the defense downsizing effort, coupled with shrinking defense budgets over the last 12 years, has been dramatic. In particular, it illustrates the difficult position senior OSD and Army officials find themselves in, when considering the fate of

Comanche. Regardless of the actual or perceived performance and value of the aircraft, the cost of cancellation has become too great. By failing to both fully support and properly fund the program over the past 20 years, or make the hard decision to simply cancel it, the Army and OSD have placed themselves in a position with little to no latitude. A decision to not produce the aircraft after almost 20 years of effort and several billions of dollars in RDT&E funds could result in the loss of yet another member of the shrinking defense industry, but more importantly, would leave the Army with a still unfulfilled armed reconnaissance requirement.

E. SUMMARY

This chapter has discussed the significant elements of the Comanche's long-term success. Three main points can be derived from a study of the program's history. They include:

1. Despite significant changes to the National Military Strategy, neither the Army's requirement for a reconnaissance aircraft nor support from the aviation community has changed. Throughout the program's history, a host of cost and alternative analyses and OSD-level reviews have confirmed both the Army's requirement and its choice of aircraft.

2. The Comanche's government and commercial program management efforts have been critical in achieving minimal deviations from planned schedules and costs, despite the numerous changes the program has endured. Management's ability to continually show improvement while adapting to changes has maintained a positive reflection on the program.

3. As the DoD downsized over the last decade, the helicopter industry has suffered the effects of the resultant smaller budgets. The result is a very fragile defense helicopter industry, and an Army that has put off other helicopter developmental programs for the past 20 years. The consequence of cancellation would include an even longer delay in satisfying the aerial reconnaissance requirement and, quite possibly, the loss of yet another military helicopter manufacturer.

The next chapter will conclude by addressing each of the thesis research questions. Additionally, it will discuss areas for further research.

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VI. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

The objective of this research effort was to document the past eighteen years of the RAH-66 Comanche's program history. The goal was to identify the significant issues, events, and actions taken by Program Managers, the Army, and other Government agencies that allowed the program to maintain its status as the centerpiece of Army Aviation modernization.

B. CONCLUSIONS

The need to understand and appreciate the history of the Comanche program and the significant events and decisions associated with its management, are critical for government officials involved in the planning, budgeting, and reporting of DoD programs. Assuming defense budgets continue to shrink, as they have throughout the Comanche's history, competition among and within the services for the limited available funds will be fierce. In fact, many programs will likely experience circumstances very much like the Comanche's. In that event, an understanding of how the Comanche PMs managed the program given

the numerous challenges they faced would be beneficial for other acquisition officials.

This research concluded that the viability of Comanche could be attributed to several factors. They include stable requirements, proficient management, and a perceived need to protect the shrinking defense helicopter industry. While the latter is clearly not under the control of a PM, he or she can, either directly or indirectly, influence the former. In the case of Comanche, each of the PMs struggled with a lack of overall commitment and budget consistency. That battle required the adoption and creation of innovative management techniques that, in the end, has maintained the viability of the program for 18 years.

C. RECOMMENDATIONS

Recommendations in two areas are indicated by this thesis effort. The first has to do with policies and processes for approving the development of new weapon systems. The Comanche program illustrates what can happen when Congress, OSD, or the Service leadership fails to fully support a program despite a valid need, or to make the equally difficult decision of cancellation. Services must be required to adequately justify the importance of not only the mission need and

operational requirement of a system, but also to demonstrate the means and the commitment to support it through production.

The second has to do with the innovative measures employed by Comanche PMs. The effect of these innovations on the viability of Comanche illustrates the importance of maintaining the capability and flexibility to tailor an acquisition program to meet a changing and challenging environment, and these should be reflected in acquisition management policies and procedures. These measures could be applied to any military acquisition to improve the ultimate result: Delivery of a product the user wanted and expected, on time and on budget.

D. ANSWERS TO RESEARCH QUESTIONS

Subsidiary Question #1. What is the history of the RAH-66 Comanche Helicopter Acquisition Program?

Chapter IV illustrates the history of the RAH-66 Comanche program, one that can be best characterized as turbulent and unpredictable. After 18 years, the program has endured a number of restructures, principally caused by budget inconsistency and perceived technological immaturity. The result is a program that according to the original acquisition strategy should be well into production, but instead is only now approaching its MS II review.

The history of the program is also replete with examples of innovation and excellence in management. From its earliest days under the management of BG Andreson, the program strived to achieve a level of performance that would reflect efficiency as well as progress, all executed in an uncertain and often unfriendly environment. This research indicates that each PM, through the implementation of resourceful management techniques such as the EOC plan, has been responsible for sustaining the program under such conditions.

Subsidiary Question #2. What was the Army's initial acquisition strategy for the Comanche program and how has it evolved?

The original baseline acquisition strategy approved on August 12, 1984, for the then LHX, established an IOC date of FY92. Through the use of a combined MS I/II review, it planned to undergo only the CE, EMD and Production acquisition phases. The strategy called for competitive development of flying prototypes through EMD, culminating with an air vehicle fly-off, with the winner entering production shortly thereafter. Total RDT&E budget was estimated at $3.2 billion.

As the program prepares to undergo its MS II review, it bears little resemblance to the baseline strategy of 18-years ago. The combined MS I/II review was terminated during the first formal restructure, in favor of a discrete PDRR phase. The use of competitive flying prototypes was

cancelled early on due to budget constraints. Down-select to a single contracting team was initiated soon after entering PDRR. The current strategy calls for an MS II decision in April 2000. EMD will include the manufacture of 14 production-quality aircraft for use in developmental testing and IOT&E. Total RDT&E budget now exceeds $8 billion dollars.

Subsidiary Question #3. What innovative measures were taken by the Program Managers in the development of the aircraft?

The Comanche program exemplified several innovative program management initiatives. Of particular interest was the use of the Design Flexibility Clause in the program's contract development. This clause allowed the contractor to perform necessary tradeoffs in order to achieve program goals, without enduring time-consuming and expensive contract modifications. Another innovative measure was the Combined Test Team (CTT). The CTT included members from the prime and sub-contractors, as well as from the program office. CTT members shared in executing test plans (including flight-tests); collecting reliability, availability, and maintainability data; and maintaining a common engineering database.

Two other significant measures instituted by the PMs must be mentioned, the EOC plan and the PPP plan. While occurring under different circumstances, their respective impacts on the program were considerable. The EOC plan was conceived under the imminent threat of

program termination. The foundation of the plan, providing the user with reconnaissance capable aircraft, was, in the researcher's opinion, what saved the program from termination and established a new program environment. The PPP plan then seized the opportunity for constructive strategy change, presented by favorable program sentiment among DoD acquisition officials, by reestablishing the former program strategy of providing production-quality aircraft to the user.

Subsidiary Question #4. What lessons can be learned from studying the history and development of the RAH-66 Comanche Helicopter program?

The primary lesson to be learned from a historical analysis of the Comanche program is the realization that a lack of commitment by Congress and senior OSD and Army leadership can quickly kill the momentum of a program that may eventually lead to its cancellation. As with any large commercial organization, if management commits itself to a product but does not adequately resource its development, its expectations will never be fulfilled.

Conversely, indiscriminate funding of a program does not insure success either. The F-22 for example, has been amply funded throughout its developmental cycle, reached EMD very early on, and is now threatened with cancellation due to perceived technological

immaturity. [Ref. 75] [Ref. 76] The Comanche's protracted development has resulted in a much more mature aircraft than what might be expected in a shorter developmental cycle. If the program receives approval to continue into EMD, it should ultimately result in significantly reduced risk.

The Comanche is a history of wavering OSD and even Army support, which translated into inconsistent budgets that resulted in a significantly delayed schedule and drastically increased costs. This program was not an example of poor program management, cost overruns, or inadequate weapon system design. The original armed reconnaissance requirement and the choice of the current Comanche helicopter to fulfill that requirement, has been verified and validated several times. Rather, this program is an example of what can occur to a good idea and a good solution, when senior leadership fails to fully support their own decisions.

Primary Research Question. What significant events and issues have occurred over the course of the RAH-66 Comanche program that have allowed it to remain a viable program?

The previous chapter illustrated three reasons that stand out as significant contributors to the viability of the Comanche program. Each plays a key role in understanding the forces at work behind Comanche.

First, while events in the world have changed the threat facing the Army, its requirement for accurate and timely intelligence, which Comanche is designed to provide, has remained unchanged. This requirement, and the subsequent choice of the current design to fulfill the requirement, has been continually evaluated by TRADOC and independent analysis throughout the history of the program and deemed relevant and appropriate.

Secondly, although both cost and schedule have become an issue with the program, it has been innovative, proactive program management by both government and contractors, which is responsible for keeping the program on track. Management's ability to continually show improvement while adapting to significant changes, has maintained a positive reflection on the program.

Finally, without any new military helicopters under development, the Comanche represents the only new development in a dwindling U. S. helicopter industrial base. Its cancellation would leave industry only DoD aircraft modification and production contracts.

E. AREAS OF FURTHER RESEARCH

This thesis was a historical analysis of a program that has endured the full spectrum of change occurring in DoD over the last two decades.

Other major programs have also had to face the same changes. A comparative analysis of two programs could be conducted to determine the impact of the military downsizing on each program and how the particular PMs or services reacted to those changes.

The research identified the importance of the involvement of the using community throughout the developmental lifecycle of a program. A historical study of user organizations, such as the Army's TRADOC System Manager, in the development of past weapon systems might illustrate effective management practices to emulate on future programs.

The Combined Test Team was an innovative management tool used by the program to combine the efforts of several organizations. The intent of the CTT was to share information between the testing community and the contractor, and reduce overall costs. A detailed analysis of this approach and its cumulative effect on the Comanche program from both a program perspective as well as from the test community's perspective might provide useful information for other programs.

Recent studies at the Naval Postgraduate School have, through the use of surveys, developed lists of program management competencies deemed most critical for PMs to possess, in order to be successful in the DoD acquisition environment. The four Program Managers of the

Comanche program discussed in this thesis each governed the program through challenging times. However, each individual was also confronted with different environments in which to manage. BG Andreson, for example, executed his duties during the height of the Reagan buildup, while Colonel Snider managed the program during the lowest defense budgets in recent history. A comparative analysis of the Comanche PMs could be conducted to determine what competencies were most important to PMs who managed the same program but under different environments. This research would provide examples to future managers as well as credibility to the current list of the competencies.

History has much to teach those that would learn from it. In terms of acquisition, the historical case analysis provides a means to assess the processes, decisions, and outcomes of program management techniques. Further historical analysis of any number of programs would aid in developing a database of useful experience for future program management personnel.

LIST OF REFERENCES

1. Lebovic, James H., Foregone Conclusion U.S. Weapons Acquisition in the Post-Cold War Transition, Westview Press, Boulder, CO, 1996.

2. McNaugher, Thomas L., New Weapons Old Politics America's Military Procurement Muddle, Brookings Institution, Washington, D.C., 1989.

3. Fox, Ronald J., The Defense Management Challenge Weapons Acquisitions, Harvard Business School, Boston, MA, 1988.

4. "The Worst Weapons," U.S. News & World Report, Vol. 107, Issue 2, p. 22-27, 10 July 1989.

5. Reames, Joseph M., "The Evolution of Requirements for the RAH-66 Comanche," SysTeam, Inc., 23 December 1999.

6. U.S. General Accounting Office report to the Honorable Peter A. DeFazio, House of Representatives, Defense Acquisitions: Comanche Program Cost, Schedule, and Performance Status, GAO/NSIAD-99-146, Washington, D.C., August 1999.

7. Gray, Wood, Historian's Handbook A Key to the Study and Writing of History, Houghton Mifflin Company, Boston, MA, 1964.

8. Tosh, John, The Pursuit of History Aims, Methods & New Directions in the Study of Modern History 2nd Edition, Longman Group, New York, 1991.

9. Allen, Matthew, Military Helicopter Doctrines of the Major Powers, 1945-1992: Making Decisions about Air-Land Warfare, Greenwood Press, Westport, CT, 1993.

10. Bradin, James W., From Hot Air to Hellfire, The History of Army Attack Aviation, Presidio Press, Novato, CA, 1994.

11. Tolson, John J., Vietnam Studies Airmobility 1961-1971, Department of the Army, Washington, D.C., 1973.

12. Stockfisch, J.A., The 1962 Howze Board and Army Combat Developments, RAND, Santa Monica, CA, 1994.

13. Hay, John H., Vietnam Studies Tactical and Materiel Innovations, Department of the Army, Washington, D. C., 1974.

14. Crouch, Major Thom, Assistant Program Manager, Test and Evaluation, RAH-66 Comanche Program, Redstone Arsenal, Alabama, Interview with the author 6 January 2000.

15. Rankin, Major Thomas Carl, "Light Observation Helicopter Acquisition, A Historical Case Study," Defense Systems Management School, November 1974.

16. Weinert, Richard P., A History of Army Aviation – 1950-1962, TRADOC, Fort Monroe, VA, 1991.

17. Jane's Online, "MD Helicopters MD 500/530," [Online] Available http://www.janesonline.com, 22 July 1999.

18. Jane's Online, "Bell Kiowa," [Online] Available http://www.janesonline.com, 22 July 1999.

19. Jane's Online, "Bell Model 209 Huey Cobra," Available [Online] http://www.janesonline.com, 15 October 1999.

20. Weapons Systems United States Army 1997, OASA (RDA), Washington, D.C. 1997.

21. Jane's Online, "Bell Model 406 (AHIP) Upgrade," [Online] Available http://www.janesonline.com, 22 July 1999.

22. "FM1-112, Attack Helicopter Operations," Headquarters Department of the Army, Washington, D.C., 1 April 1997.

23. Federal Association of Scientists, "AH-64 Apache" [Online] Available http://www.fas.org/man/dod-101/sys/ac/ah64.htm, 1999.

24. Shoop, Major Brian, Assistant TRADOC System Manager for Test & Evaluation, RAH-66 Comanche, Ft. Rucker, Alabama, Interview with the author 3 January 2000.

25. TSM Comanche, "LHX Operational Requirements Document," [Online] Available http://www-rucker.army.mil/TSMC/ordset.htm, Ft. Rucker, Alabama, December 1997.

26. Jane's Online, "Boeing Sikorsky RAH-66 Comanche," [Online] Available http://www.janesonline.com, 22 July 1999.

27. RAH-66 Comanche Program Manager's Office, "Defense Acquisition Executive Summary," 6 October 1999.

28. U.S. Army, PEO Aviation Website, RAH-66 Comanche, [Online] Available http://www.peoavn.redstone.army.mil/hq/ams/ams.htm].

29. Boeing Rotorcraft, "RAH-66 Comanche," [Online] Available http://www.boeing.com/rotorcraft/military/rah66/rah66photos.htm

30. Sweetman, Bill, "Scout Blazes a Trail, Smaller Armed Helicopters are an Increasingly Practical Form of Attack Aircraft," Janes International Defense Review, Vol. 029, Issue 008, pp. 34-46, 1 August 1996.

31. Army Technology, "RAH-66 Comanche – Reconnaissance/Attack Helicopter," [Online] Available http://www.army-technology.com/projects/comanche/indes.htm, 1999.

32. Moore, Alan, "Comanche is Coming," Soldier, Vol. 53, Issue 11, pp. 22-25, November 1998.

33. Williams, Michael D., Acquisition for the 21st Century: The F-22 Development Program, National Defense University Press, Washington, D.C., 1999.

34. Riegart, Captain Paul M., A Case Study: Acquisition Reform and the New V-22 Osprey Program, Master's Thesis, School of Systems Management, Naval Postgraduate School, Monterey, CA, March 1999.

35. Office of Management and Budget, OMB Circular A-109, "Major Systems Acquisitions," 5 April 1976.

36. Department of Defense Directive 5000.2-R, Mandatory Procedures for Major Defense Acquisition Programs (MDAP) and Major

Automated Information Systems (MAIS) Acquisition Programs, 15 March 1996.

37. Defense Acquisition Deskbook, Glossary Defense Acquisition Acronyms and Terms, March 1999.

38. Schmoll, Joseph H., Introduction to Defense Acquisition Management, Defense Systems Management College, Fort Belvoir, VA, June 1996.

39. Department of Defense Directive 5000.1, Defense Acquisition, 15 March 1996.

40. Defense Systems Management College. The Program Manager's Notebook, Fort Belvoir, VA, June 1993.

41. Defense Acquisition Deskbook, DoD-Wide Practices, March 1999.

42. Light Helicopter Family 1987 Acquisition Strategy, 30 November 1987.

43. U.S. General Accounting Office, DoD Acquisition: Case Study of the Army Light Helicopter Program, GAO/NSIAD-86-458-1, Washington, D.C.,

44. Orf, Carolyn, Chief, Business Activities, Unpublished Internal PMO Document, Redstone Arsenal, Alabama, January 2000.

45. Reames, Joseph M., Senior Engineer, SysTeam, Inc., Ft. Rucker, Alabama, Interview with the author 3 January 2000.

46. Snider, Major General James R., Program Executive Officer, Aviation, Redstone Arsenal, Alabama, Interview with the author on 5 January 2000.

47. Congressional Quarterly 1987 Almanac, Congressional Quarterly Inc., Washington, D.C., 1987.

48. Greely, Brendan M., "Defense Dept. Orders Shake-Up In Army Aviation Master Plan," Aviation Week & Space Technology, Vol. 128, Issue 3, p. 20, 18 January 1988.

49. Greely, Brendan M., "Army to Award Parallel Contracts for Revised Development of LHX," Aviation Week & Space Technology, Vol. 128, Issue 11, pp. 247-248, 14 March 1988.

50. U.S. General Accounting Office report to the Honorable Sam Nunn, Chairman, Committee on Armed Services, United States Senate, Defense Acquisition Programs: Status of Selected Systems, GAO/NSIAD-90-30, Washington, D.C., December 1989.

51. Congressional Quarterly 1988 Almanac, Congressional Quarterly Inc., Washington, D.C., 1988.

52. Greely, Brendan M., "Boeing-Sikorsky Team Unveils Preliminary Design for LHX," Aviation Week & Space Technology, Vol. 129, Issue 16, p. 31, 17 October 1988.

53. Bond, David A., "U.S. Army Revamps Comanche Plans, Considers Next Bid for More Funds," Aviation Week & Space Technology, Vol. 136, Issue 11, pp. 20-22, 16 March 1992.

54. RAH-66 Comanche Program, Program Update Briefing, The Need for Comanche," December 1999.

55. Fulghum, David, "Comanche Production Slashed in First Five Years," Aviation Week & Space Technology, Vol. 140, Issue 26, p. 28, 27 June 1994.

56. Kitfield, James, "The Top Government Purchases: Army – Upgrades are the name of the game," Government Executive, Vol. 26, Issue 8, pp. 102-106, August 1994.

57. Fulghum, David A., Morrocco, John D., "New Defense Cuts Target Comanche, TSSAM," Aviation Week & Space Technology, Vol. 141, Issue 16, pp. 18-19, 17 October 1994.

58. Congressional Quarterly 1995 Almanac, Congressional Quarterly Inc., Washington, D.C., 1995.

59. Bergantz, Brigadier General Joseph L., Program Manager, RAH-66 Comanche Program, Redstone Arsenal, Alabama, Interview with the author 6 January 2000.

60. RAH-66 Comanche Program, "Acquisition Strategy Report for the RAH-66 Comanche Program," 2 February 1999.

61. Boeing "Boeing Sikorsky RAH-66 Comanche Team Delivers $3.1 Billion Proposal to U.S. Army," [Online] Available http://www.boeing.com/news/releases/1999/news_release-990823.htm.

62. Cohen, William S., Prepared Statement of the Honorable William S. Cohen to the Senate Armed Services Committee, Hearing on Operations in Kosovo, Washington, D.C., July 20, 1999.

63. Defense Acquisition Deskbook, Wisdom, March 1999.

64. Morris, Jim & Matson, Rick, "A Model for Procurement Success: The Comanche Program," Army RD&A, January–February 1996.

65. U.S. General Accounting Office report to the Honorable Nicholas Mavroules, Chairman, the Honorable Larry J. Hopkins, Ranking Republican Member, Subcommittee on Investigations, Committee on Armed Services, House of Representatives, Comanche Helicopter: Program Needs Reassessment Due to Increased Unit Cost and Other Factors, GAO/NSIAD-92-204, Washington, D.C., May 1992.

66. Ward, Major Timothy M., "Comanche Combined Test Team Leading The Way To Future Testing," [Online] Available http://dacm.sarda.army.mil/publications/rda/marapr97/ctt4.html.

67. Congressional Quarterly 1989 Almanac, Congressional Quarterly Inc., Washington, D.C., 1988.

68. Congressional Quarterly 1991 Almanac, Congressional Quarterly Inc., Washington, D.C., 1991.

69. "RAH-66 Tests Need an Extra $40 Million in Funding," Jane's Defense Weekly, p. 10, 19 April 1997.

70. Persinos, John, "The Comanche Conundrum," Rotor & Wing, pp. 28-36, August 1998.

71. Dorr, Robert F., "The Republic and the Republicans," Aerospace America, Vol. 33, Issue 1, New York, January 1995.

72. Kitfield, James, "Modernization in a holding pattern," Government Executive, Vol. 27, Issue 8, pp. 103-106, August 1995.

73. "Army Seeks Final Black Hawk Buy," Aviation Week & Space Technology, Vol. 142, Issue 7, New York, 13 February 1995.

74. Aboulafia, Richard, "Poised for Prosperity" Rotor & Wing, Vol. 33, No. 12, pp. 28-33, December 1999.

75. U.S. General Accounting Office, Defense Acquisition: Progress of the F-22 and F/A-18E/F Engineering and Manufacturing Development Programs, GAO/NSIAD-92-204, Washington, D.C., 17 March 1999.

76. Fulghum, David, "Budget Ceasefire Predicted Until After Elections," Aviation Week & Space Technology, Vol. 152, Issue 6, pp. 30-31, 7 February 2000.

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