Comanche – The Road to Milestone II

Success Dependent on Total Team Effort

MAJ. GEN. JOSEPH L. BERGANTZ, USA

Looking more like a strange 11,000-pound dragonfly than an advanced weapon with a deadly sting, the Comanche RAH 66 twin-engine advanced technology helicopter is designed to get up close to the action and locate where the enemy is. Flying at 200 miles per hour, Comanche literally sees in the dark and is well suited for its primary mission of aerial reconnaissance on the modern battlefield.

With fielding scheduled to begin in December 2006, the Army wants about 1,200 Comanches.

A New Path

On April 4 the Comanche program completed a successful Milestone II review. This event was the culmination of a great deal of hard work by the entire Comanche team – government and contractor. The entire effort took approximately 18 months to complete, beginning with an Overarching Integrated Product Team (OIPT) meeting on June 30, 1998.

At this meeting, the Comanche program was redirected on a new path to accelerate the fire control radar development; to bolster the modeling and simulation portions of the program for both engineering and operational activities; and finally, to deliver a production representative set of prototype and Initial Operational Test and Evaluation aircraft, produced on production representative tooling. All agreed at the OIPT that these programmatic improvements were for the better.

As a result, the Office of the Secretary of Defense approved the new program strategy. Another important component of the new acquisition strategy was acceleration of the Milestone II decision point from October 2001 to April 2000. This was key – decision makers recognized that the program had conducted significant risk-reduction work, had demonstrated many of the critical pieces of technology, and that it was time to move on to integrating and testing those subsystems together.

Two follow-up OIPT meetings in December 1998 and July 1999 served as way points to check the program's progress as it proceeded to a Milestone II review in April 2000. At the December OIPT, the Cost and Analysis Improvement Group (CAIG) noted that the program funding profile for the remainder of development was short in the fiscal 2000 and fiscal 2001 time frames. As a result, the Congress added $40 million in fiscal 2000, and the Army added $52 million in fiscal 2001. Both of these additions reduced technical and schedule risk in the near term.

Trade-offs

One of the biggest constraints in adapting to the new strategy was living within the funding resources available at the time. To do that, we had to make many program trade-offs over the following year and a half to reduce cost, while maintaining schedule and performance. We could not have done this without the TSM (Training and Doctrine Command System Manager) and his team, who helped review the system requirements and schedule, using Cost As an Independent Variable (CAIV) techniques.

Also critical to success in adapting to the new program strategy was the close working relationship between government and the Boeing-Sikorsky prime contractor team. We used Alpha contracting extensively throughout, precluding the need for a separate and distinct proposal evaluation board activity. This saved the government a significant amount of money and, more importantly, time. Both of these techniques will be discussed in more detail later in this article.

Bottom-Up Cost Estimate

Throughout 1999, the Comanche government team worked closely with the contractor team to develop a bottom-up program office cost estimate for the total life cycle costs of Comanche. The program estimate is quite detailed and covers all cost areas such as bill of materials, manufacturing manhours, and direct and indirect engineering manhours.

In December 1999, we reached cost closure and conducted a bottom-up risk assessment of the entire program, with results presented at an internal Integrated Baseline Review (IBR). This review is typically done within six months after the contract award. However, we opted to conduct the IBR prior to the Milestone so that we could better understand risk going into the review cycle.

Risk Management

The risk assessment evaluated a total of 185 areas, with 83 assessed as moderate, 102 as low, and no areas assessed as high risk. We used an automated assessment tool across the board, so everyone had the same set of definitions for levels of risk. This review was quite beneficial as it focused the program office on specific areas where there was need for management emphasis. These areas will be targeted for specific award fee incentives to assure continued contractor emphasis and desired performance. In addition, we prepared mitigation plans for each moderate area of risk, which were in place by the contract award date for Engineering and Manufacturing Development (EMD), the final development phase.

An example area of focused risk management is software development. This is an area that normally plagues all electronics-intensive weapon systems. To address risk in software development, the Comanche program has taken a serious internal look at its resources and processes. We not only reviewed these

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The cornerstone of the new Army vision – the RAH-66 Comanche. The Comanche armed reconnaissance/attack helicopter will swiftly resolve crises and conflicts by fully exploiting the benefits of the digital battlefield. It is a premier early entry system with a small footprint that is easily transportable. It can readily self-deploy. It flies deep, armed reconnaissance missions to give the commander a detailed real-time analysis of the crisis area and the adversary within. It has the extended range and lethality for performing light attack, armed reconnaissance, and deep strike missions.

U.S. Army photos

MAJ. GEN. JOSEPH L. BERGANTZ, USA

Program Executive Officer, Aviation

Army Maj. Gen. Joseph L. Bergantz was promoted to the rank of major general and reassigned as the Program Executive Officer (PEO) Aviation, Redstone Arsenal, Ala., effective July 31, 2000. Reporting directly to the Army Acquisition Executive, he is the Army manager for the Apache, Comanche, Improved Cargo Helicopter, Aviation Electronic Combat, Aircrew Integrated Systems, and Advanced Threat Infrared Countermeasures/Common Missile (ATIRCM) Warning Systems programs. Prior to his promotion and reassignment, Bergantz was the Program Manager, RAH 66 Comanche at Redstone.

A native of Huntingdon, Pa., Bergantz graduated from the U.S. Military Academy at West Point and was commissioned as a Field Artillery (FA) officer in 1971.

His formal military training includes Airborne and Ranger schools, FA officer basic and advanced courses, rotary and fixed-wing training, Armed Forces Staff College, the Program Management Course at DSMC, and Army War College. He holds a master's degree in Aerospace Engineering from Georgia Tech and a master's degree in Engineering Management from the University of Missouri (Rolla).

Bergantz has served in a wide variety of acquisition positions, ranging from Research and Development Coordinator, Light Helicopter Office and Advanced Product Manager (APM) for Longbow Apache to Department of the Army and Office of the Secretary of Defense-level staff assignments.

Other key assignments include Platoon Leader, 71st Aviation Company (AH); Battery Commander, A Battery, 3/35th FA; associate professor at West Point in the Mechanical Engineering Department; Product Manager for Communications Intelligence Aircraft; and Commander, Aviation Technical Test Center.

at the prime team developers, but also at the subcontractors, who provide a significant amount of software development within the overall program.

In addition to internal reviews, the program office has also scheduled a Tri-Service external review to benefit from an independent assessment of potential software problem areas and identify the appropriate software metrics to track throughout the Comanche EMD phase.

Alpha Contracting

Alpha contracting was another area where we made significant strides leading up to Milestone II. Briefly, Alpha contracting is a practice in which the government team meets with the corresponding contractor team prior to negotiation to consider where cost differences and technical misunderstandings exist and resolve them to the maximum extent possible during the period of interaction. Once the program office had committed to the new program direction in 1998, we used Alpha contracting consistently. This was new territory for the program, and it was thus a learning experience for both the contractor team and the program office.

Both parties agreed early on that it did not make sense to require a formal proposal evaluation process, conducted in the traditional way of constituting an offsite team to handle this mission as a special mission activity. Instead, we used our IPTs, already in existence, and used Alpha contracting techniques. After having gone through this experience, we heartily endorse this way of negotiating and evaluating proposals. It certainly saves a significant amount of time and effort.

While it is difficult to quantify a total cost savings to the program, clearly Alpha contracting certainly reduced risk to the program, as well as saving time and effort. Subject matter experts were not taken away from their everyday jobs and segregated into a separate area. They were instead able to continue doing their normal jobs as the process unfolded. While all members of the team remained busy, their efforts were more productive due to Alpha contracting, contributing greatly to the program's maintaining cost and schedule performance.

Some specific examples of how Comanche combined Alpha contracting techniques with the IPT process and CAIV principles are noteworthy.

Alpha Contracting and IPTs

For instance, at the grass roots level, each IPT had certain technical constraints within which to live, as well as development cost, production Design to Cost (DTC), and Design to Operations and Support Costs (DTOSC) goals. In the case of the Comanche radar, for example, we estimated all the costs associated with the development, integration, and testing of the radar at the lowest level of the Work Breakdown Structure (WBS). We did this not only for the subcontractors (Northrop-Grumman/Lockheed Martin) who provide it, but also at the Boeing-Sikorsky prime contractor level,

where it is integrated with all other subsystems on the aircraft.

We assigned each IPT weight goals at the lowest WBS level, which they had to meet to keep the entire aircraft's weight on track and within budget. In addition, we continually adjusted the DTC and DTOSC cost goals as this process evolved, making appropriate trades as necessary along the way to stay within funding constraints. As unexpected external funding changes occurred, the program office made internal program adjustments to cost, schedule, or performance to drive the program to a balanced situation.

The process produced a working plan to see this program through to the end of development in December 2006. We laid out all the necessary pieces in detail and costed, scheduled, and assessed them in terms of risk. At the end of this process, when we finally reached closure with our prime contractor team, we had achieved an executable program that fit within the schedule and funding available with low to medium risks. It remains a challenging program, requiring focused management as one would expect.

Alpha Contracting and CAIV

CAIV also played an important role in program definition. The program office, working closely with the contractor team and the TSM's office, participated in a requirements review of the 1993 Operational Requirements Document (ORD). This review pointed out necessary modifications to the ORD to update it and make it relevant to the type of warfare we are now seeing and expect to see over the next 10–15 years.

The result of this review led to some requirements being deleted, some being added, and some being moved to the growth section of the ORD. The program office then structured the Comanche program to satisfy the new ORD requirements and developed a block upgrade approach for future growth capabilities. The program will continue to use CAIV principles during EMD to help keep the program on track in terms of cost and schedule.

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Exit Criteria

A major element in the Milestone II process was the completion of a set of milestone Exit Criteria that were mutually developed among the program manager and outside organizations, primarily the testing community. These criteria were set at levels less than the full-up specification, but high enough to demonstrate significant progress in meeting the full-up specification. The Comanche program had seven exit criteria:

- Second Generation Forward-Looking Infrared Radar (FLIR) Performance
- Ballistic Survivability of Five Components
- Vertical Rate of Climb (VROC) Performance
- Readiness and Supportability
- Radar Signature
- Infrared (IR) Signature
- Comanche Radar Moving Target Acquisition Range.

Second Generation FLIR Performance

We demonstrated performance of the second generation FLIR using Minimum Resolvable Temperature measurements and models to confirm the performance of the targeting FLIR. In addition, we flew the FLIR on a Blackhawk helicopter as a surrogate platform. This demonstration took user pilots from Fort Rucker, Ala., and allowed them to detect typical targets at Fort A.P. Hill, Va.

The pilotage FLIR also demonstrated second generation performance on an Apache helicopter as a surrogate platform. Both FLIRs lived up to expectations, and all user pilots confirmed that the second generation FLIR is definitely a vast improvement over our current first generation technology.

Ballistic Survivability of Five Components

In the area of ballistic vulnerability, component firings were done on the tail rotor drive shaft, the main rotor quill shaft, and the internal fuel cell. Two other previously fired component tests were deemed acceptable. In every case, the components performed at the prescribed levels and, in some cases, exceeded expectations.

For example, the fuel cell firing provided some very interesting results. The Comanche is a nearly all-composite airframe. As the fuel cell was shot on the static test article, the structural keel beam behind it bowed due to the force of impact, then quickly sprang back to its original shape. The resiliency of composites, and the way they react to shots, in many cases contribute to increased survivability. For example, the typical spalling seen with metal airframes is not nearly as prevalent with composites, thereby reducing secondary effects.

Vertical Rate of Climb (VROC) Performance

The VROC provides a composite measure of excess power. This excess power translates into maneuverability and agility for various combat maneuvers (e.g., rapid lateral displacement or unmasking and re-masking). We measured VROC, both

by hovering vertical free flight and tethered hovering flight. The Comanche is required, in primary mission configuration with the radar installed, to achieve at least a 500-feet-per-minute vertical rate of climb performance on a 95-degree Fahrenheit day at 4,000 feet pressure altitude. Such performance will ensure that the Comanche will be able to operate satisfactorily in 95 percent of the potential combat environments, under high/hot conditions. The prototype aircraft demonstrated 510-feet-per-minute VROC performance, adjusted to the conditions specified here. Our measured VROC significantly exceeded the milestone exit criteria.

Readiness and Supportability

The Comanche has embedded diagnostics to help the crew and maintainers correctly detect and isolate system faults. Two subsystems, the secondary power unit and the flight control system, were injected with faults to demonstrate Comanche's fault detection and isolation capabilities, under the readiness and supportability rubric. The line replaceable modules that go into the mission computers each have approximately 25 percent of the board layout dedicated to on-board diagnostics. This, in conjunction with the Portable Maintenance Aid (PMA), allows the maintainer to correctly detect and isolate faults.

The PMA is a ruggedized laptop computer that not only allows the maintainer to download and identify faults, but also walks him or her through the proper troubleshooting techniques and replace or repair procedures. Twenty faults were inserted at random into the secondary power unit, and 25 faults were inserted into the flight control system. The fault detection and isolation system correctly found every fault, and the PMA correctly troubleshot and guided the maintainer through the appropriate corrective actions to address those faults.

Radar Signature

The most challenging portion of the Comanche radar signature is the radar cross section (RCS) on the nose of the aircraft. This is due to the complex shapes, moving parts, and optical windows involved. A full-scale model of the nose was built and tested on the Lockheed Martin test range in Orlando. These results were then added to full-scale pole model results from an earlier test to build up a composite signature of the aircraft. The results confirmed that Comanche had exceeded its exit criteria and came very close to meeting its ultimate required signature level.

Infrared (IR) Signature

The other survivability exit criterion dealt with the IR signature. The Comanche has a unique tail cone mixing chamber, where hot gases from the engines are cooled. The Comanche was tested side-by-side with a suppressed utility helicopter and proved at all conditions to have a much smaller IR signature. In fact, the Comanche had again surpassed its exit criteria, and again nearly met its requirement for the end of development.

Comanche Radar Moving Target Acquisition Range

The final criterion demonstrated was Comanche radar performance in finding typical moving tank targets at 80 percent of the required range. This demonstration was initially done at the Northrop-Grumman tower facility, near Baltimore-Washington International airport. Initial test results indicated acceptable performance out to 49 percent of the required range. Antenna losses were observed, which had to be overcome. The team made interim fixes, as appropriate. Additional testing was conducted in March at Yuma Proving Ground, Ariz., on a calibrated range with M-60 and T-72 tank targets at the prescribed 80 percent range. The results of the Yuma demonstration indicated that the Moving Target Indicator portion of the radar met the exit criteria. The ability to complete this additional testing and demonstrate a marked improvement in performance is a real success story in terms of government and industry working together as a team.

Finalizing Documentation

Comanche's performance in satisfying the exit criteria outlined in this article certainly helped secure approval to continue development at the milestone review. During the two months prior to the Defense Acquisition Board, the Comanche Program finalized all its documentation requirements, including some new documents to the program. For example, the Command, Control, Communications, Computers, and Intelligence (C4I) plan was completed for the first time and coordinated with both the Army Director of Information Systems for Command, Control, Communications and Computers (DISC4) and the Office of the Secretary of Defense (OSD) Command, Control, Communications and Intelligence (C3I) offices. That document is particularly important as it addresses many of the ways that Comanche will be able to capitalize on its information dominance capabilities.

Analysis of Alternatives

The final major effort that was progressing in parallel was the Analysis of Alternatives (AoA). The AoA was led by OSD Program Analysis and Evaluation (PA&E), with the majority of the work done by the Army. Specifically, TRADOC Analysis Center (TRAC), Fort Leavenworth, Kan.; Fort Lee, Va.; White Sands Missile Range, N.M.; as well as the Army Materiel and Systems Analysis Agency (AMSAA) did the lion's share of the work, with help from the program office and user involvement from Fort Rucker, Ala.

The AoA working group met at least once monthly, and the council of colonels and the Senior Advisory Group met every six to eight weeks. These groups reviewed progress of the analysis and provided guidance to redirect efforts and resolve problems along the way. The analysis was very robust in that it addressed a host of different major scenarios—four in Southwest Asia, one in Northeast Asia, and two in Europe Command (EUCOM), with both high and low resolution. Three alternatives were studied:

Alternative 1
: The current OH-58D and AH-64D fleet.

Alternative 2
: A fleet of AH-64Ds and RAH-66s, with varied Comanche radar mixes.

Alternative 3

A similar fleet of AH-64Ds and RAH-66s, but with the RAH-66 degraded in RCS, weight, and maintenance burden. (Alternative 3 was run to gain sensitivities around three major features of the Comanche.)

In addition to these three alternatives, a fourth alternative concerning a Comanche and Tactical Unmanned Aerial Vehicle (TUAV) mix was performed independently under the Manned/Unmanned concept exploration project by the Training and Doctrine Command.

In terms of cost, Comanche Alternatives 2 and 3 cost about $10 billion more than Alternative 1, the majority of which is the actual production cost of a new aircraft.

Operationally, the Comanche alternatives provide an improvement in force effectiveness and survivability in all cases. The Comanche force displayed more proactive and deliberate engagements at higher optempo. Comanches provided improved target detection times and ranges, which allowed many battles to be brought to a decisive conclusion sooner. Comanche forces achieved earlier detection at greater ranges permitting more use of artillery, such as the Multiple Launch Rocket System (MLRS) and other supporting fires. Comanche, augmented by TUAVs, reduced the overall blue losses and collateral damage.

Finally, Comanche alternatives had enhanced reliability, availability, and maintainability at lower personnel costs, including the degraded Comanche alternative. Thus, the AoA highlights the Comanche's significant contribution to the warfighter in terms of cost and operational effectiveness.

Reaching the Goal Line

Along the way to the milestone, the program team learned some very relevant lessons. These have to do with the acquisition process, the IPT process, the budget process, and other related acquisition activities.

Good Communication

Probably the single most important lesson learned from this experience is that good communication is required both up and down the government chains, as well as back and forth with the contractors, to ultimately reach the goal line. To that end, I believe the IPT process is working. It serves as the right forum for passing information to senior leaders, enhancing program management, and resolving issues as they arise.

IPTs work best when the working-level members report back to the senior leader on topics discussed and strive to achieve consensus of the group in resolving issues. As leaders receive this information, it's incumbent upon them to tell their representatives what their positions are so that their representatives can properly present those stated positions at the IPT meetings.

Three issues arose in our pursuit of Milestone II concerning IPTs:

Limitations of Contractor Representatives

IPT members were sometimes contractors, who often spoke for government offices as if they were government employees.

Communicating IPT Issues to Senior Leaders

IPT issues were not transmitted back to the senior leader or were transmitted, but garbled. With the staffing drawdown and agencies left shorthanded, we are faced with an ever-increasing number of contractors to do the work. Learning the limitations of contractor representatives in government decision forums is very important. At our IPT meetings, we tried to insist that a government employee (either civilian or military), representing his or her organization, always be present when decisions were being made.

To address the second issue, we tried to take detailed notes from IPT meetings and convert them to meeting minutes, distributing them quickly to IPT members to ensure accuracy and responsiveness. This worked fairly well. In retrospect, it would have been smarter to also send these minutes to the senior leaders, to keep them informed from the program office perspective, in addition to the information they got from their representatives.

Identifying the Issues

The other issue we had with IPTs was initially getting representatives to identify their issues. After some intervention from senior-level leaders, the process was kick-started and issues came forward. Once the issues were identified, the IPT forum worked well in resolving them. It helped focus the resolution process, served as the right meeting place for the key people to come together, and helped the program office adjust talent and resources to accommodate resolutions.

Staging Area

Another initiative that we implemented to improve efficiency was to establish a staging area in Crystal City, Va., at a contractor's site for use as a base for IPT meetings, internal program meetings, and also for completing administrative tasks such as copying and preparing briefings. This base went into full-fledged operation about two weeks prior to the Army Systems Acquisition Review Council (ASARC) and shut down two days after the Defense Acquisition Board. This was one of the smartest things we did. It gave us the option of a dedicated meeting room when those in the Pentagon were booked, as well as providing a very convenient place to adjust briefings as the process and issues unfolded.

In Retrospect

Getting through a successful milestone review is a lot of hard work, but is definitely a highly rewarding experience and well worth the effort. Success is highly dependent on a total team effort. Both industry and the government players must proactively pull together to stay on schedule and produce an executable plan. In doing so, the final product can be a win-win for all concerned.

Editor's Note: For more information, go to the Comanche PMO Web site at **http://www.comanche.redstone.army.mil/logo_rah.html**.