# Comanche Crew Station Development

## "Mockpit" Lets Comanche Fly in Simulation Long Before Actual Aircraft Production

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During the two years leading to Engineering, Manufacturing and Development (EMD) Milestone approval in April 2000 for the Comanche RAH-66 advanced technology helicopter, the Army Training and Doctrine Command (TRADOC) System Manager (TSM), Program Manager (PM), and industry team initiated design and process improvements related to both physical and cognitive aspects of Comanche's crew station design. These improvements, made possible only by recent unprecedented advances in computer processing technology, allowed the Comanche program to maximize user involvement early in the process of designing a weapon system with the best possible pilot-vehicle interfaces.

### Modeling and Simulation, Computer Aided Design

A variety of modeling and simulation tools provide the means to obtain feedback from developmental test pilots and Army aviators with combat experience. Computer Aided Design tools and other leading-edge human engineering models and simulations allow the weapon system developer to iterate potential airframe design solutions to satisfy issues arising from the user feedback. And, simulations allow the materiel developers to evaluate how well the crew station design accommodates human cognitive processes to ensure the crew workload and pilot training techniques are effective.

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### "Growing the Cockpit"

Based on user input and a preliminary Army Research Laboratory–Human Research and Engineering Directorate (ARL-HRED) evaluation indicating that the Comanche cockpit may have been too small, a Crew Station Process Action Team (CSPAT) was formed that included members from the Aviation Technical Test Center, Aviation Research and Development Center, the ARL-HRED, and the program office/industry team. The question, "Do we need to grow the cockpit?" needed to be answered prior to the Weapon System Design Review, six months away at the time. The impact of "growing the cockpit" would be substantial, including expansion of the existing aircraft outer mold line.

Historically, "human factors" engineers evaluated the adequacy of a cockpit design after an aircraft was built, taking measurements in the aircraft itself. Although two prototype aircraft existed at the time of the study, planned design changes for future aircraft would further impinge on cockpit volume. Also, the total population required to be accommodated within the cockpit increased in 1996 after design of the existing prototype aircraft. Fortunately, significant improvements over the past five years in human engineering tools and human figure modeling allowed the CSPAT to conduct an "early intervention" without need for an actual aircraft.

The first step in answering the overarching question about the cockpit was to resolve a longstanding disagreement about the design eye point (DEP). Because of perceived flaws in previous analysis based on helicopters with floor-mounted cyclics and questions about formal guidelines, the CSPAT decided to determine the actual measured eye reference point (MERP). The CSPAT's hypothesis was that a pilot using a side-arm-controller would sit in a more erect posture than one using a cyclic control.

**FaroArm**

We developed a methodology to locate the MERP, which included placing 20 subject aviators, including TSM pilots, in the full-scale Comanche mockup. We then used a FaroArm to measure the location of specific anatomical features. The FaroArm, originally designed for surgical applications, measures a point location in three dimensions to 2-sigma accuracy.

The evaluation concluded that none of the earlier DEP analysis and guidelines adequately predicted the MERP. We were left with two alternatives for the application of our data: a major redesign, or

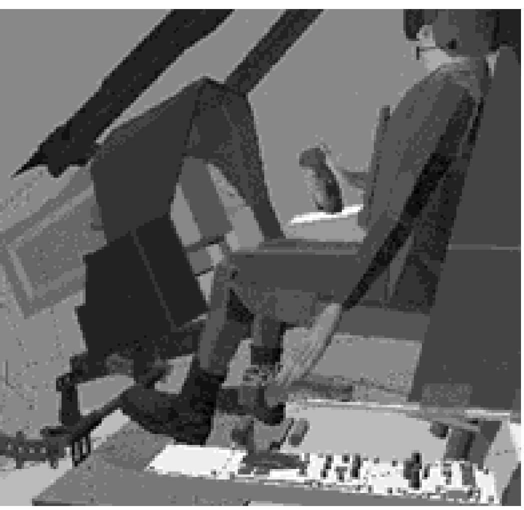


Photos/Images courtesy Comanche PMO

a minor redesign in such a way as to place the MERP as close to the Comanche DEP as possible. We proceeded with the latter, since the variances were minor and fewer perturbations were created in the total aircraft design.

Once the industry-government team was satisfied that the DEP was properly placed, it proceeded to determine whether the cockpit design provided adequate knee clearance; a specific concern to the TSM pilots and the ARL-HRED preliminary evaluation. The CSPAT evaluated knee clearance accommodation in three segments.

- First it was necessary to take measurements in the aircraft using the FaroArm to ensure that the computer-graphic-aided 3D interactive applications (CATIA) data accurately represented the actual aircraft.



**Transom Jack Model**

- Second, we needed to use the data we collected to conduct modeling using Natick-developed human figures to represent the required population in the Transom Jack model. Transom Jack allows the modeler to place figures of varying dimensions in a cockpit built with CATIA design data. The human figure modeling effort allowed us to develop recommendations for the design engineers.
- Finally, to quantify the population that the cockpit accommodated in various design iterations, the CSPAT sought the help of Naval Air Warfare Center Crew Station (NAWC 4.6) to conduct statistical modeling similar to that which they developed for the Joint Primary Aircraft Training System. Based on the CSPAT's input, the crewmember's seat was redesigned from one that adjusts on a single axis to one that allows dual-axis adjustment. The CSPAT's effort showed that expanding the outer mold line was not necessary. Comanche will provide the necessary anthropometric accommodation for knee clearance with a seat redesign.

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The CSPAT has continued its collaboration with industry, the user, and NAWC to identify design changes that will improve accommodation for both reach and ingress/egress requirements in the same fashion as was accomplished for knee clearance.

## Process Improvements

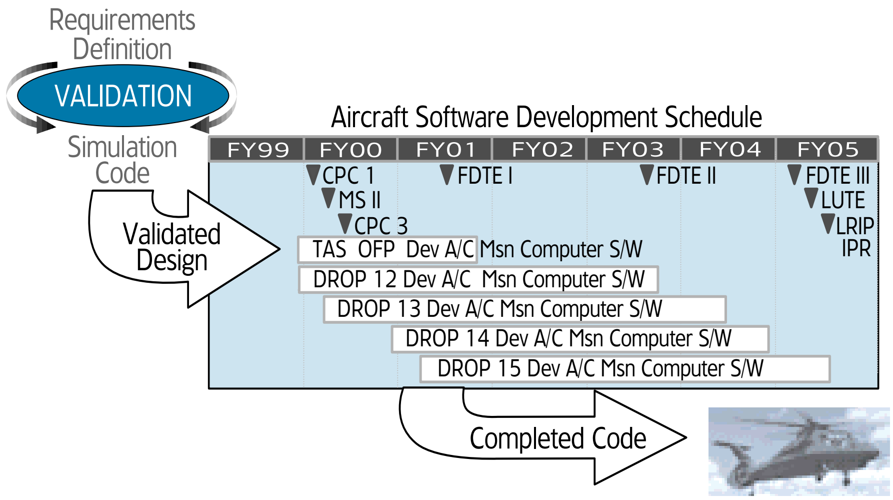
While the anthropometric evaluation was ongoing, we developed a Crew Station Working Group (CSWG) Charter with subordinate teams to address issues related to each of 21 crew station components. The charter defined the process for identifying issues (any member may raise an issue) and specified that membership on each of the component teams would include prime contractor crew station designers, software engineers, PM representatives, Combined Test Team (CTT) pilots, and TSM pilots.

The CSWG Charter further specified the process for elevating issues that could not be resolved at the component team level. The forum has resulted in an opportunity for the materiel developer to solicit input from the user and for the input to be integrated into the design. The process improvements have allowed the CSWG to resolve a substantial number of pilot-vehicle interface (PVI) issues.

## Cognitive

While the Operational Requirements Document and Performance Weapon System Specification identify the requirements, the prime contractor's Pilot Vehicle Interface Mechanization Specification details how the requirements for PVI will be met. Physical design requirements are straightforward compared to narrative descriptions of functionality such as display menu structure and flight symbology.

To limit potential misunderstandings, Sikorsky Aircraft (SA) developed a cyclic process of requirements definition and simulation to ensure that the more abstract aspects of crew station were understood and met the requirement before writing aircraft code. eDesktop simulation capability at the geographically disparate locations of the TSM, CTT, PM, and SA make it possible for all




## Requirements Definition and Simulation

members of the component teams to see the same picture and limits misinterpretations of text.

### Enter the "Mockpit"

We coined the term "mockpit" to describe the virtual cockpit, which is comprised of a Silicon Graphics O2 computer and virtual prototyping software. The reusable crew station simulation code is written in C++, copied to a CD-ROM as an executable file, and mailed to each of the mockpit locations. The team can fly the Comanche crew station configuration in simulation as much as 18 to 24 months prior to its implementation into the actual aircraft.

On a larger scale, SA recently restructured its Cockpit Analysis Program into a three-phased design validation using a combination of simulation environments.

#### Phase I

In Phase I, CTT and TSM pilots evaluate individual design components using the mockpit and other virtual prototyping tools.

#### Phase II

During Phase II, the CSD team combines the individual component designs with an evaluation of the crew station design impact on human performance and aircrew workload during mission segments using CTT and TSM pilots in the Sikorsky full-motion engineering design simulator (EDS) at Stratford, Conn.

#### Phase III

Phase III, also performed in the EDS, will be a single-ship, full-mission simulation using U.S. Army Forces Command pilots as participants. It is timed to precede Force Development Test and Experimentation I, a multi-ship, full-mission event. During the first two phases of the validation process, we expect results related to crew station design. Although we expect to continue learning about the design in Phase III, the emphasis will shift to a focus on learning how to train new Comanche pilots.

### Comanche RAH-66 — Classic Example of Simulation Based Acquisition (SBA)

The Comanche team's use of modeling and simulation tools to evaluate the physical and cognitive aspects of the Comanche cockpit is a classic example of SBA techniques. The simulations enhance user participation in the design process and support process improvement initiatives. The combination of these tools and earlier, continuous user involvement in the design process results in prompt identification and resolution of potential design problems and prevents cost and schedule impacts from significant problems found late in a program's life cycle.

The Comanche team's efforts will ensure that the EMD aircraft are ready for user testing, and will result in a far superior Comanche product at Milestone III.

**Editor's Note:** The authors welcome questions and comments on this article. Contact Chase at **chased@comanche.redstone.army.mil**; Copeland at **bob.copeland@comanche.redstone.army.mil**; and Ferrell at **ferrellr@comanche.redstone.army.mil**.

## New COTS and Commercial Item Guide Released

The new Commercial Off-the-Shelf (COTS) and Commercial Item Guide, *Commercial Item Acquisition: Considerations and Lessons Learned*, was published online July 24. Released by Assistant Secretary of Defense (Command, Control, Communications and Intelligence) Arthur L. Money, and Under Secretary of Defense (Acquisition, Technology and Logistics) Dr. Jacques S. Gansler, the Guide is designed to assist DoD consumers in acquiring and supporting commercial items.

According to both officials, "We [DoD] must expand the use of commercial items in DoD systems so we can leverage the massive technology investments of the private sector; reap the benefits of reduced cycle times; faster insertion of new technologies; lower life cycle costs; greater reliability and availability; and support from a robust industrial base ... We encourage you to learn from it and use it as you design your acquisition strategies."

**Editor's Note:** The Guide may be downloaded from the Deputy Under Secretary of Defense (Acquisition Reform) Web site at **www.acq.osd.mil/ar**.