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US ARMY AVIATION SYSTEMS COMMAND
AVIATION RESEARCH AND TECHNOLOGY ACTIVITY

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US ARMY
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SYSTEMS COMMAND

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MOFFETT FIELD, CA 94305-1099

Crew Station Research and Development Facility Training for the Light Helicopter Demonstration/Validation Program

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Summary

The U.S. Army Crew Station Research and Development Branch (CSRDB) of the Aircraft Simulation Division, AVSCOM, was tasked by the Light Helicopter Program Manager (LH-PM) to provide training to Army personnel in advanced aircraft simulation technology. The purpose of this training was to prepare different groups of pilots to support and evaluate two contractor simulation efforts during the Demonstration/Validation (DEM/VAL) phase of the LH program. The personnel in the CSRDB developed mission-oriented training programs to accomplish the objectives, conducted the programs, and provided guidance to Army personnel and support personnel throughout the DEM/VAL phase. The conduct of these training programs was partially supported by Contract NAS-2-12849.

Background

The Request for Proposal for the DEM/VAL portion of the LH development program contained requirements for engineering, part-task, and full mission simulation. The full mission simulation description specified that the Government assess the contractors' simulations with regard to the adequacy of the operational realism of the simulators. To assist the contractor teams, the government was asked to assign a group of pilots to each of the contractors during the entire DEM/VAL program for employment as Subject Matter Experts (SMEs) in the development of the cockpits to be used for simulation at each contractor site. These Support Pilots were AH-64A and Army Helicopter Improvement Program (AHIP) (OH-58D) pilots who were trained at the Crew Station Research and Development Facility (CSRDF) in two groups during March and April of 1989. A separate group of pilots was required to perform the operational assessment of the contractor simulators in tactical scenarios. These Assessment Pilots were also AH-64A and AHIP pilots who were trained at CSRDF in three distinct phases, each with a different objective.

A group of Engineering Test Pilots was trained with the Assessment Pilots at the CSRDF. Their role was to assess the flight handling qualities of the contractors' simulators compared with ADS-33 standards.

Operational personnel responsible for developing, implementing, and orchestrating the scenarios required for the operational assessment were provided support, training, and practice in their tasks at the CSRDF. These personnel included the Test Director for the Operational Assessment and members of the Operational Assessment Team. Technical personnel responsible for developing, orchestrating, and testing the technical scenarios required for the Technical Assessment were provided support, academic and technical training, and practice in their tasks at the CSRDF. These personnel comprised an Engineering Test Pilot, a Research Analyst functioning as a copilot and Systems Operator, and the other members of the Technical Assessment Team.

Strategy

Both the support and assessment groups consisted of operational pilots with little or no exposure to the environment of glass cockpits, advanced Mission Equipment Packages (MEPs), and full mission simulators. For this reason, the pilot training program was primarily directed toward providing familiarization with the advanced technologies currently proposed or available for such a cockpit. "Technology Familiarization" was the primary goal of both the Support Pilot Training program and the first phase of the Assessment Pilot Training program.

The training strategy resulted in an approach that would familiarize the pilots with advanced cockpit technologies in general. To avoid a strong tendency on the part of the pilots to judge the contractor's simulator relative to the one on which they were trained, the cockpit controls and displays of the CSRDF were not emphasized, even though

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the CSRDF simulator was the only simulator the pilots flew during the training program.

During technology familiarization, the pilots were presented general concepts and high level information about various advanced technologies in classroom lecture format. A concerted effort was made, however, to present a variety of examples of how these technologies have been implemented. The pilots were reminded that the examples presented may or may not represent good implementations of those technologies. This approach was intended to diminish the tendency to judge the MEPs of the contractors' simulators relative to any other simulator MEP, and to express judgement of a MEP on its own merit.

Throughout Assessment Pilot training, data were gathered on the pilots' performance. These data were used in two ways: (1) as a basis for assigning equivalent groups of pilots to each contractor; and (2) to detect extremes in performance by any of the pilots.

Table 1. Support pilot training program summary

Topic	Total time, hr
Introductory materials, administrative briefings, discussions, facility description and tours	5.50
Introduction to simulation lectures	4.00
Technology familiarization lectures	9.00
Helmet fitting	0.50
EXPERT87	2.00
Mission planner demonstration	1.50
Computer-based training	2.00
Crew station flight time	2.00
Team station flight time	2.00
Experimenter-operator console observation	0.50
Mission briefing/discussion	1.50

Support Pilot Training Program

Training of the Support Pilots (Subject Matter Experts) associated with the LH DEM/VAL program was accomplished in the Spring of 1989. The goal of the four-day course was to familiarize the operational pilots with the advanced technologies proposed or available for the LH glass cockpit environment. Lectures were presented in Simulation Basics and Technology Familiarization. The pilots were exposed to advanced technology system components available in the CSRDF.

The twelve Support Pilots participated in the training program in two groups of six pilots each. An additional group of six pilots attended the training program; four were trained with the first group of Support Pilots, and two were trained with the second group. These additional pilots were involved with the LH DEM/VAL in other roles and attended the lectures which were presented, but their involvement with other training activities was allowed on a non-interference basis (i.e., simulator flight time was arranged only when it had no impact on the Support Pilots' scheduled time). Table 1 summarizes the four-day training program.

Because of the short training time, only a brief exposure to the Crew Station Facility could be accommodated. The feedback received from this program indicated the pilots learned a great deal about glass cockpits, but would have preferred more hands-on time with all events, such as Computer-Based Training, the Smart Command Recognizer, and EXPERT87. These topics will be described in more detail in the Assessment Pilot Training section which follows.

Assessment Pilot Training Program

The Assessment Pilot Training was accomplished in three distinct phases, totalling five weeks of training time for each of twenty pilots. The goals of the overall program were: (1) to provide a general introduction to simulation (Simulation Basics); (2) to familiarize pilots with advanced glass cockpit technologies (Technology Familiarization); (3) to provide pilots with hands-on experience flying advanced cockpits; and (4) to provide experience in simulation protocol. Lectures were presented in Simulation Basics and Technology Familiarization, addressing similar content to that which was taught to the Support Pilots. Phase I training was an expanded version of the Support Pilot Training Program. Some additional activities were added to the Assessment Pilot program, e.g., each pilot had a custom-fit helmet made for flying at the CSRDF, and more attention was paid to the mission scenarios to be flown at the contractors' sites.

Phase I

Two groups of ten pilots attended the two-week course for Phase I Assessment Pilot training. One group was trained in November, and the second group was trained in December, 1989. The curriculum included classroom lectures in Simulation Basics and Technology Familiarization, hands-on experience using Computer-Based Trainers, demonstration and practice using the Helicopter Operations Planner (HOP) for mission planning, demonstration and use of the Smart Command Recognizer used in the CSRDF, acquisition of mission effectiveness judgements using EXPERT87, Team Station operations,

and CSRDF training for both front and back seats. See table 2 for a summary of the Phase I training.

The classroom lectures were provided to present in-depth information about Simulation Basics and Technology Familiarization. These lecture periods were distributed throughout the two-week course, with tours and hands-on experiences interspersed to maintain interest and attention levels. The lectures were accompanied by slide displays and videotape presentations. The major topics addressed under the Simulation Basics category were: Visual Systems, Motion and Fixed-Base Simulators, Simulator Sickness, Crew Coordination, and Performance Measurements. Data relevant to simulator side effects (e.g., simulator sickness) were collected throughout the training program.

Table 2. Assessment pilot Phase I training summary

Topic	Total time, hr
Introductory materials, administrative briefings, discussions, facility description and tours	7.75
Introduction to simulation lectures	3.00
Technology familiarization lectures	6.25
Introduction to SWAT and card sort	2.00
Helmet pouring and adjustment	1.75
Voice system enrollment	1.00
Template polishing	1.50
Speech command practice	0.75
EXPERT87	1.00
Mission planner practice	1.00
Computer-based training	4.50
Crew station flight time	7.50
Team station flight time	7.50
Experimenter-operator console observation	1.50
Scenario discussions	2.50

The major topics addressed under the Technology Familiarization category were: Flight Controls, Helmet-Mounted Displays, Multi-Function Displays, Communications and Data Link Capabilities, Aided Target Recognition, Weapons Management, Digital Maps and other Navigational Aids, Sensor Systems (FLIR), Speech Input and Output, and Mission Planning. As with the Simulation Basics materials, training aids were used and demonstrations provided whenever they were available and appropriate.

Computer-based trainers– The Computer-Based Trainers (CBTs) were used to teach system level tasks associated with operating the two principle displays in the CSRDF. Four training stations were available so that pilots could go through exercises in small groups. Each training station included two multi-function displays with touch-sensitive screens, which were similar in presentation and operation to the displays in the CSRDF. Pilots were required to perform a structured sequence of exercises which began with tutorial demonstrations and progressed to presentation of interactive problem sets. The problem sets provided brief questions concerning the operation of different CSRDF subsystems. Pilots responded by touching the appropriate keys on either or both of the displays. When an answer was completed, the CBT presented feedback to the pilot in terms of a score describing how well they answered each question and timing feedback. The problem sets were intended to test the pilots' knowledge of the subsystems he would be required to operate in the CSRDF. Pilots were required to progress through the entire lesson plan once, and were permitted to repeat any tutorials or problem sets.

Helicopter operations planner– The Helicopter Operations Planner (HOP) was used to demonstrate mission planning capabilities. The HOP plans ingress and egress routes based on threat positions, density, and the altitude at which different segments of the mission must be flown (e.g., nap of the earth, contour). The pilots were presented background information concerning integrated mission planners, and were given a demonstration to illustrate how the HOP could be used to plan missions.

Smart command recognizer– The pilots were shown the capabilities and limitations of current speech recognition and synthesis technology. Speech input and output design features were illustrated. The Smart Command Recognizer (SCR) was employed to enroll speech templates for the pilots and to train them to use a set of speech commands in the Crew Station Facility. Speaker-dependent templates were developed which included a 108-word vocabulary. Commands were available to control communications, the digital map, and to request flight and weapon stores information. The SCR features flexible command wording, feedback of spoken commands, and methods for correcting recognizer errors. Through the use of the SCR, the pilots also became familiar with the synthesized speech messages that they might hear in the Crew Station.

EXPERT87– EXPERT87 is a PC-based software package originally developed to be a decision-aiding tool. Starting with a high-level construct such as Mission Effectiveness, EXPERT87 facilitates the specification of factors that would be possible contributing factors to the construct (e.g., for Mission Effectiveness these factors might be performance in each of the following areas:

Navigation/Pilotage, Communications, Targeting/Threat Management, etc.). Once these have been defined, the software determines the importance placed on each of these factors by an individual pilot in several interactive sessions. The DEM/VAL pilots were presented with information about the background and intent for using EXPERT87 in a classroom, and then allowed to spend about an hour using the package.

Team station operation– Pilots were given instructions concerning the operation of the Blue and Red Team Stations which played roles as wingmen or enemy aircraft in the practice missions flown by the pilots during this training phase. During CSRDF mission flights, the pilots each gained experience operating the Team Stations.

Crew station operation– Each pilot was given an opportunity to operate the CSRDF simulator from both the front and back seats. While in the front seat, the pilots were given instructions for flying the simulator. When the pilots were in the back seat they were provided with instructions and guidance in operating the cockpit controls and displays, weapons systems, and target acquisition sensors. Pilots flew a short mission, allowing them to obtain an overview of capabilities and functions.

Phase II

Four groups of five pilots attended the two-week course for Phase II Assessment Pilot training. The first group of pilots was trained in January and the last group of pilots was trained in April, 1990. The curriculum included classroom lectures in Tactical Standard Operating Procedures, Threat Disposition, pre-mission briefings; hands-on experience using the Computer-Based Trainers, and extensive CSRDF simulator and Team Station flight training. In addition, the pilots went through an EXPERT87 session and participated in other related research projects. See table 3 for a summary of the Phase II training.

The classroom lectures were provided to present information concerning tactical requirements for different types of missions. Except for the first day of training, the pilots received one lecture period each day. The first training day was spent covering administrative items and providing review sessions for the material covered in Phase I training. The pilots completed all of the CBT exercises and contributed to EXPERT87 on the first day. Lecture topics included Armed Reconnaissance, Light Attack, Threat Logic, and Air-To-Air Combat.

Computer-based trainers– The Computer-Based Trainers were used to provide refresher training for the CSRDF simulator controls and displays. No demonstrations were presented; only interactive problem sets were used. The pilots were given a pre-test to establish a baseline of their retained knowledge. Following that, two problem sets posed questions to the pilots and provided step-by-step solutions to the problems. In contrast, two other problem sets posed questions without providing answers, and finally, the pre-test was administered again (as a post-test) to judge the effectiveness of the training. This process required approximately 3 hours to complete.

Table 3. Assessment pilot Phase II training summary

Topic	Total time, hr
Lectures, TAC SOP, threat briefings	10
Mission preparation briefings	7
Computer-based training	2.5
Review and discussions	5
Front seat crew station flight time	9
Back seat crew station flight time	9
Team station flight time	9
EOC observation	5
ATR study participation	6
HMD study participation	2

Crew station training– A Crew Station Refresher course was presented before the pilots spent any time in the cockpit, and the CBT training was also conducted before CSRDF simulator flight training. The first day in the cockpit was scheduled to re-acquaint the pilots with the systems. The time was unstructured and was designed to relax the pilots in the simulator. Each pilot flew once every day in both the front and back seat of the CSRDF simulator.

The next four days of training concentrated on different cockpit subsystems in a building block format. Pilotage and Navigation was stressed first, followed by Communications and Battle Resource Management. Targeting and Aircraft Survivability Equipment were emphasized next, and finally Weapons Management was practiced. Each day's exercises included reviews of tasks from the previous days. The training tasks were specifically tailored for each seat and for the Team Station player. For example, the Pilotage and Navigation exercises required the Battle Captain (in the back seat) to enter waypoints and plan a route to perform a simple flight objective. The Pilot (in the front seat) was given flight instructions by an Instructor Pilot (IP) to learn how to fly the simulator. When the Pilot had accomplished the required maneuvers, the Battle Captain guided him to the planned route and the two of them worked on cockpit/crew coordination to accomplish the objective. This training plan continued with the addition of tasks related to the other cockpit subsystems.

Finally, a short practice mission was flown, prior to flying a Reconnaissance Mission and a Light Attack Mission. The pilot's tactical performance was rated following each of these two missions.

Study participation– Two research projects not related to the LH DEM/VAL program were conducted during the Phase II training program and pilots were required to contribute part of their time to these projects. One study was concerned with assessing user acceptance of an Aided Target Recognition by using an emulation of a proposed system. The other study sought pilot input for determining the criteria important to display of aircraft system symbology on a helmet-mounted display.

Phase III

Phase III training was conducted just prior to the actual Operational Assessment at the contractor sites. The pilots were assigned to a contractor team before participating in Phase III training (see Pilot Assignment Process section). Two groups of ten pilots each attended the four-day course. The first group was trained in June, and departed the CSRDF to attend a two-week training program at the First Team's simulation site in Connecticut. The second group was trained in July before going to Arizona to attend a two-week training program at the Super Team's simulation site. For both groups, the contractor's Operational Assessment immediately followed the contractor training program.

The purpose of the Phase III training at the CSRDF was to train assigned crews in the crew positions that they would fly during the actual Operational Assessment. The pilots comprising each crew flew in the same position for each mission. (Note that during Phases I and II, all pilots flew in both seats.) Each two-man crew consisted of an AH-64 pilot who flew in the front seat, and an OH-58D pilot who flew in the back seat. Two additional pilots operated as wingmen for the missions. The pilots flew four tactical vignettes which closely resembled those that would be used for the operational assessment. Two reconnaissance and two attack missions were flown over the four days; one mission was flown by each of the four crews each day. The two-man crews worked as teams to plan each mission using the Helicopter Operations Planner, and they briefed the wingmen regarding the role they were to play for each mission. Following each mission, a tactical debriefing was conducted.

The curriculum for Phase III included classroom briefings in Subjective Workload Assessment Technique use, Aircraft Survivability Equipment operations, and Threat situation. These topics were addressed because of their importance in the conduct of the Operational Assessment. Other topics included: demonstration and use of the HOP for pre-flight route planning; CSRDF or Team Station flight time; and participation in on-going research activities. See table 4 for a summary of the Phase III training.

Table 4. Assessment pilot Phase III training summary

Topic	Total time, hr
Administrative briefings, lectures	6.25
Crew station missions	8.0
Mission planning	2.0

At the end of Phase III training, the Assessment Pilots were prepared to continue at the contractors' sites, where specific training for the contractors' simulators was provided by both contractors.

Pilot Assignment Process

Immediately after Phase II training was completed, the twenty DEM/VAL Assessment Pilots were divided into two groups which would be subsequently assigned to one of the two contractor teams competing on the LH program. The CSRDB was tasked to establish the criteria for assigning the pilots to two comparable groups. The objective was to achieve a balanced representation of experience, background, and other relevant variables.

Constraints on the assignment process were as follows:

- Four pilots from Aviation Development Test Activity (ADTA) were assigned as two crews, one crew to each contractor group.
- Two pilots representing the TRADOC System Manager (TSM) were *a priori* designated to be team station operators, one assigned to each group.

Because these constraints accounted for six of the twenty pilots, the decision rules pertained only to the assignment of the remaining fourteen pilots into two groups of seven pilots. Each group consisted of three two-man crews (two primary crews and one back-up) and one team station operator. Final determination of the back-up crew and the two primary crews within each group was made at the contractor site following the contractor's training program.

Approach– The general approach to pilot assignment was as follows:

1. Assign pilots to two groups on the basis of hard data (i.e., aircraft type and tactical flight hours).

2. Assign pilots to crews on the basis of quantified subjective ratings made by Army Subject Matter Experts (SMEs).

3. Test the equity of the outcome by subjecting it to critical review by independent SMEs.

4. Allow the TRADOC Systems Manager (TSM), LH to resolve any issues raised by the critical review, and to be responsible for assigning the final groups to the specific contractor teams.

Assignment criteria– Relevant criteria for pilot assignment were determined by representatives from Aeroflightdynamics Directorate (AFDD), Test Command (TEXCOM), Director of Combat Development (DCD), Army Materiel Systems Analysis Activity (AMSAA), and Operational Test and Evaluation Agency (OTEA) in a meeting at NASA Ames Research center on January 22, 1990. The variables were selected on the basis of being quantitative (or quantifiable) measures relevant to the projected role of the LH DEM/VAL assessment pilots.

The two variables used for initial division into two balanced groups were: aircraft type (AH-64 vs OH-58D), and tactical flight experience. Data pertaining to these variables were readily obtained from existing pilot profiles supplemented by a brief interview session with the pilots regarding unit assignments and duty positions.

Other variables which contributed to the assignment criteria were: mission success, tactical aptitude, situation awareness, flying ability, decision making, Mission Equipment Package (MEP) usage, and attitude. Four Army SMEs from TEXCOM, DCD, AMSAA, and TSM provided judgments of relative weights (importance) of these variables, separately, for the Pilot and Battle Commander crew positions. The mean ratings were calculated to establish the variable weights.

Three Army SMEs rated the Assessment Pilots on the seven listed variables during four full-mission simulations in the CSRDF during Phase II Assessment Pilot training. Each pilot flew twice in the front seat and twice in the back seat, and was rated on his performance. The pilot rating data were computed using a decision matrix to weigh and sum the SME ratings of the assessment pilots. This decision matrix produced a single composite score for each pilot. These scores were used to determine pilot pairings.

Pilot assignment process– The fourteen FORSCOM pilots were separated by aircraft type (AH-64 and OH-58D) into two groups of seven. These two groups were sorted by total number of tactical flight hours, from high to low. From these two groups, one pilot was excluded based on the percentage difference between his tactical flight hours and the tactical flight hours of the pilots who had the most similar number of tactical flight hours (i.e., the pilots who had just more or just less total tactical flight hours according to the hierarchical sort).

Each of the remaining three pairs of pilots in each aircraft type were split to determine assignment to Contractor A and B. The assignment to A or B was done by tactical flight hours in the following order, beginning with the highest number:

AH-64 Pilots = AB BA BA

OH-58D Pilots = BA AB AB

Crew pairings– Crew pairs were created through the use of the ratings obtained in Phase II CSRDF training. For Group A and B independently, the composite rating scores of the three pilots from each aircraft type were rank ordered. The middle scoring pilots were paired; the highest scoring AH-64 pilot was paired with the lowest scoring OH-58D pilot; and the lowest scoring AH-64 pilot was paired with the highest scoring OH-58D pilot.

Assignment process overrides– The Army SMEs, led by the TEXCOM representative, reserved the right to adjust crew assignments and pairings to avoid apparent inequities or logistical problems. Two changes were made to the group assignment process by the Army SMEs. One of the OH-58D pilots who was assigned as a console operator was switched with another OH-58D pilot assigned as one of the three crews for one team. The SMEs determined that the pilot originally assigned to the console could be equated (on the basis of tactical flight hours) with another pilot because the absolute difference in their flight hours (as opposed to percentage difference in tactical flight hours) was less than the absolute difference between the two pilots based on the original assignment process. In addition, the pilot who would have been selected through the original assignment process had a serious problem with simulator sickness during his training at the CSRDF, and required medication to avoid becoming sick. The medication slowed his reaction times and affected his decision-making performance in the Crew Station.

The original assignment process placed two Department of Evaluation and Standardization (DES) Pilots on the same team. The second change was made to avoid this. The OH-58D DES Pilot assigned to Team A was switched with his counterpart (in terms of tactical flight hours) in Team B.

Critical review process– After the assignment process was completed, the outcome was subjected to a critical

review. Three Army Aviation SMEs were identified by the TSM, LH to form a "Red Team." They were provided with a list and description of the pilots assigned to the two groups. The groups were not affiliated with either contractor and individual pilots were not identified by name.

The Red Team determined that both groups were evenly matched along biographical parameters such as age and rank. Professional qualifications were also matched. The discriminators for matching the two groups identified by the Red Team were: total rotorcraft hours, tactical flight hours, simulator hours, and the subjective analysis of individual pilot performance by the SMEs during Phase II training. The most critical discriminators according to the Red Team were tactical flight hours and simulator hours.

The Red Team analysis of the two groups showed no significant difference in tactical flight hours. One group had 50% more simulator time than the other group. This difference was attributable to one pilot who had 900 hours in fixed-wing, commercial simulators. The Red Team did not judge this experience to be pertinent to the Simulation Assessment. On the basis of rotary wing military simulator time, there was no difference between the two groups.

A small, and statistically insignificant, difference was shown between the two groups in the SME subjective ratings of pilot performance during Phase II training. These data were not viewed as decisive by the Red Team.

The Red Team concluded that the two groups of pilots provided for optimum matching based on the discriminators utilized. They recommended that each group should be randomly assigned to each contractor, and that these groups of pilots should be used to conduct the Simulation Assessment (i.e., they recommended no changes to the groups on the basis of their review).

Assignment of groups to contractors– After the two groups were identified, the TSM, LH was responsible for determining which group went to which team. This decision could have been made by either a random process, or based on logistical constraints.

Conclusions

Each of the two groups of pilots were trained at the contractor sites in preparation for the Operational Assessment. The training they received was adequate to prepare them for their tasks as Operational Assessment pilots.

The Operational Team Members (the Test Director for the Operational Assessment and his support personnel) received sufficient training at the CSRDF to understand and orchestrate the mission scenarios which were to be evaluated. They obtained a good understanding about the operational use of a simulator facility.

The Technical Team Members also received adequate training in the technical aspects of simulation to prepare them for their mission objectives. The Technical Team dry runs conducted at the CSRDF were extremely valuable in preparing the team members in the use of time management, methodology, data collection and evaluation methods.

The DEM/VAL training program proceeded smoothly and accomplished the stated objectives: operational pilots were trained to support the DEM/VAL phase of the LH program, mission-oriented programs were developed, and guidance was provided to Army personnel to support the DEM/VAL program. The CSRDF staff benefitted by learning more about Army tactics and doctrine, and by an ongoing association with Army personnel to accomplish similar objectives from different perspectives.

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