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Closed Cockpit Flight in the U.S. Army: The AH-64 Experience (Reprint)

by Morris R. Lattimore, Jr. and John S. Crowley



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a monocular display of the external environment via television or thermal sensors on the nose of the aircraft. This requires the pilot to transform his/her visual processing from an egocentric, binocular, wide-angle, constant resolution view of visual space to a remote-sourced, monocular, narrow-angle, variable resolution view of that same visual space. This transformation must then be integrated with learned motor responses yielding proficient flight of the aircraft. Although this closed cockpit phase of training is generally acknowledged to be particularly demanding, the failure rate is low, demonstrating the profound plasticity and adaptability of the human visual system. There is a measurable incidence of motion sickness ("bag sickness"), but this generally resolves within a few flights.

Undoubtedly, much thought by tacticians and aeromedical researchers will occur before operational closed cockpit combat flying becomes doctrine. In the meantime, the U.S. Army AH-64 experience, combined with accumulating evidence in HMD test programs around NATO, is reassuring. It appears that flying safely in a closed cockpit mode may be feasible, given proper training, procedural safeguards, and tactical adjustments.

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Closed Cockpit Flight in the U.S. Army: The AH-64 Experience

Morris R. Lattimore, Jr., O.D., Ph.D.

COLONEL. MS. U.S. ARMY

Director, Aircrew Health & Performance Division

John Crowley M.D.

LIEUTENANT COLONEL. MC. U.S. ARMY

Director, Aircrew Protection Division

U.S. Army Aeromedical Research Laboratory

Fort Rucker, AL 36362. USA

ABSTRACT

There is a growing sense that combat helicopters and crewmembers in future conflicts will need a "closed cockpit" flight capability. The challenges of the closed cockpit are numerous and relate to the aircraft as well as the human operator. While many aeromedical and human factors concerns remain to be explored, much can be learned from experimental flight test data collected over recent years, as well as the extensive operational experience with helmet mounted displays (HMDs) in the U.S. Army.

The AH-64 "Apache" helicopter has been in the U.S. Army arsenal for over 15 years. AH-64 transition flight training routinely includes a 2-week training period known as flying "in the bag." In this "bag" phase of training, the student's cockpit windows are completely covered, thus eliminating all direct visualization of the outside world. The objective is to compel the student pilot to fly the aircraft solely by reference to the AH-64 HMD, known as the Integrated Helmet and Display Sighting System (IHADSS). The IHADSS provides a monocular

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display of the external environment via television or thermal sensors on the nose of the aircraft. This requires the pilot to transform his/her visual processing from an egocentric, binocular, wide-angle, constant resolution view of visual space. to a remote-sourced, monocular, narrow-angle, variable resolution view of that same visual space. This transformation must then be integrated with learned motor responses yielding proficient flight of the aircraft. Although this closed cockpit phase of training is generally acknowledged to be particularly demanding, the failure rate is low, demonstrating the profound plasticity and adaptability of the human visual system. There is a measurable incidence of motion sickness ("bag sickness"), but this generally resolves within a few flights.

Undoubtedly, much thought by tacticians and aeromedical researchers will occur before operational closed cockpit combat flying becomes doctrine. In the meantime, the U.S. Army AH-64 experience, combined with accumulating evidence in HMD test programs around NATO, is reassuring. It appears that flying safely in a closed cockpit mode may be feasible, given proper training, procedural safeguards, and tactical adjustments.

INTRODUCTION

Combat operational flight requirements now emphasize all weather and night flight capabilities. Doctrinally, this has been the operational goal for several decades; only in the last 10 years or so have significant advances been made in these arenas. The AH-64 Apache attack helicopter utilizes a Helmet Display Unit (HDU) as a part of its Integrated Helmet and Display Sight System (IHADSS) to provide the pilot with a 30° x 40° view of the world from a nose-mounted camera. The camera can provide either a zoom-capable (up to 8X) daytime TV view, or a forward-looking infrared (FLIR), black and white view for use at night (or in day training to mimic night activity). This display system provides a cathode ray tube (CRT) -based image to the right eye using an optical collimator mounted on the right side of the helmet. The image has a peripheral instrumentation overlay so that the aviator can "see" the outside world while simultaneously monitoring key aircraft flight data, thereby theoretically providing a closed cockpit flight capability (Figures 1-3).

This imaging system requires the pilot to transform his/her visual processing from an egocentric, binocular, wide-angle, constant resolution view of visual space, to a remote-sourced (i.e., nose-camera based), monocular, narrow-angle, variable resolution view of that same visual space. This transformation must then be integrated with learned motor responses yielding proficient flight of the aircraft. This theoretical possibility is actually a training reality for 2 weeks of the 14-week Apache transition course. Although this closed cockpit phase of training is

generally acknowledged to be particularly demanding, the failure rate is apparently low, demonstrating the profound plasticity and adaptability of the human visual system.

The Apache transition course includes 2 weeks of daily 2-hour training flights under blacked-out windscreen conditions referred to by the aviators as flying "in the bag." During these flights, the sole means of providing the flight student visual contact with the outside world is via the HDU. The instructor pilot (IP) is not so limited, having free windscreen visibility. As an additional safety factor, all "in the bag" flights are made in daytime VFR conditions (Figures 4 and 5). While the goal of this demanding training task is to enhance aviator adaptation to flight using the imaging system, closed cockpit combat is not a considered capability at this time.

While "in the bag" flight training has been a reality for 14 years, no one has attempted an assessment on the safety of flight under this limited condition. Therefore, given the contextual implication that a closed crew environment poses unique performance issues, we probed the U.S. Army Safety Center (USASC) database to assess whether or not such an environment poses a potential safety hazard.

METHODS AND RESULTS

The Directorate of Training, Doctrine, and Simulation (DOTDS) at Fort Rucker was contacted regarding Apache training historical data. Since 1985, over 4,000 Apache pilots have been trained; more recently over 330 per year go through the program. On an annual basis, 6,600 Apache flight hours at Fort Rucker are "in the bag." Projected back 14 years, that translates to over 90,000 flight training hours in a closed cockpit environment. The training program itself includes all aspects of flight: hover, taxi, take-off, cross-country flight, nap of the earth (NOE) flight, landing zone maneuvering, weapon gunnery, landing approach, taxiing, and hover to landing.

The USASC database was text-searched for "AH-64 mishaps while the night vision system was in use, or night vision system mission, with rated student pilot." Within the stated limiting context, this probe achieved 83 hits or occurrences over the period 85-10-01 to 99-01-19, the date of our inquiry. Only five summaries specifically stated the mishap occurred during daytime, pilot night vision sensor (PNVS) bag training conditions; none of those clearly-identified events resulted in injury or major damage. The typical mishap summary (i.e., in three of the five cases) depicted detection of minor damage on postflight inspection (dent in stabilator, scratched main rotor, tail rotor drive shaft cover cracked). One accident summary specifically stated "during day PNVS training, the pilot touched down

hard during a roll-on landing causing the tail wheel strut to collapse.” The last identified an event that was not tied to “in the bag” flight (e.g., “during a day NVG system training flight the ‘vib gear box’ light illuminated: after landing, the intermediate gear box was replaced.”). By our review of these summaries, if there is any systematic difficulty at all with flying in the bag, it is associated with degree of peripheral awareness on close proximity maneuvers (four of the five mishaps). Seventy-seven of the other 78 mishap summaries, none of which specified day bag PNVs flight, were overwhelmingly similar to the last clear “in the bag” example, whereby a caution light was responded to, and corrective action was taken. None involved injury or major damage.

One major exception occurred in 1993. It was not reported under an “in the bag” scenario. However, local training staff identified this event as occurring on what was scheduled as an “in the bag” flight. The USASC summary stated, “While ground taxiing, the AH-64 aircraft was struck by a violent, sudden burst of wind from the left rear. This caused the aircraft to become airborne in an extreme nose-low attitude and spin rapidly to the right. After approximately 180 degrees of spin, the main rotor system flexed down into the right side of the front cockpit canopy, instrument panel, and nose of the aircraft, followed immediately by rotor blade contact with the asphalt taxiway. The IP in the front cockpit sustained fatal injuries” (from USASC text-search). The report does not state whether the student or IP was at the controls at the time, but protocol would have dictated the student would have had the controls.

DISCUSSION AND SUMMARY

Closed cockpit flight has already been investigated in a structured, scientific fashion in the Augusta A 109 helicopter (Gradle, 1990) with the conclusion that tactical flight in a closed cockpit is possible. Additional work by Crowley, Johnson, Rash and Verona (1991, 1998, and 1998) in the areas of degraded image simulation and the effects on helmet mounted display-based flight performance further demonstrate the basic practicality of closed cockpit flight. However, these studies highlighted the drawbacks of air or motion sickness as an initial dis-actor to flight efficiency.

Since this initial review of USASC mishap summaries is not a definitive examination, the drawing of explicit safety conclusions from so few incidents is not feasible. However, this basic review of 14 years of training data, constituting over 90,000 flight hours, indicates closed cockpit or closed environment flight may not be an overtly dangerous or unsafe activity. It is conceded, however, that this is with a safety pilot whose view is

unimpeded. Pure closed cockpit flight for both pilots is currently unexplored. The USASC review of the one fatal mishap associated with the database search parameters did not associate closed cockpit flight as being contributory, or even present but not contributory, to the event or final outcome. Given the exclusion of that event, there has been to date no injury or major damage clearly associated with closed cockpit flight. Our initial subjective impression of this program is that close-quarters flight is more difficult in the bag, but it is not an insurmountable difficulty. Whether or not this could transition to dual-pilot closed environment combat is yet to be determined.

REFERENCES

1. Gradle RP. Visual problems associated with the helicopter closed cockpit. Annual Meeting of the Aerospace Medical Association. New Orleans, LA. 13-17 May, 1990.
2. Rash CE, Verona RW, Crowley JS. Human factors and safety considerations of night vision systems flight using thermal imaging systems. USAARL Report No. 90-1 0. 1991.
3. Crowley JS, Johnson PA. Simulating a degraded visual environment in the helicopter. Farnborough, UK Report No. DERA/CHS/PP5/CR980006/1.0, 1998.
4. Crowley JS. Simulated degraded visual environment for the helicopter: effect of ventilator failure Farnborough UK Report No. DERA/CHS/PP5/CR980006/1.0, 1998.

Figures



Figure 1 AH-64 Apache



Figure 4 "In the bag" rear seat arrangement.



Figure 2 IHADDS HDU in place over the right eye.

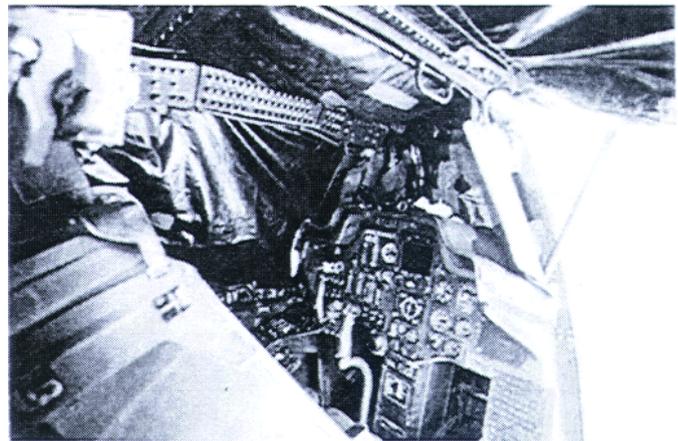


Figure 5 Closer view of "in the bag" rear cockpit.

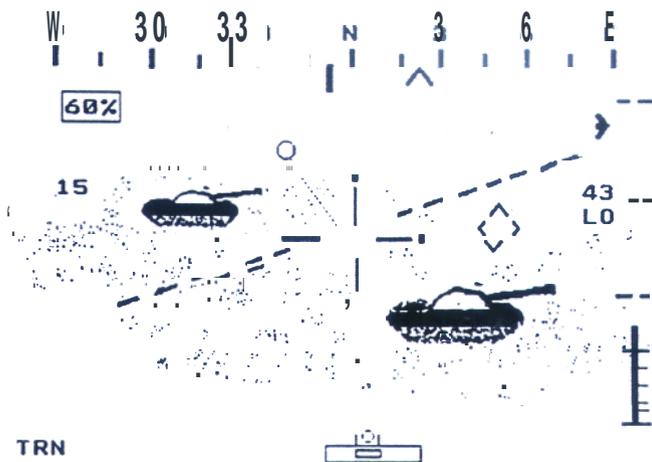


Figure 3 Simulated HDU image with peripheral flight symbology.